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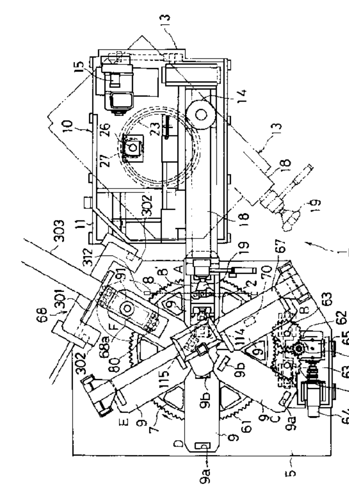
(54) **Blow molding machine.**

(57) In a blow molding machine, a mold for clamping a parison is arranged below an extruder (10) extruding the parison ; the parison (2) is cut above the upper surface of the mold (8, 8') so as to leave an upper flash on a molded article. The blow molding machine is operative to perform an article removing process, in which the configuration of the upper end of the parison is corrected into a flat and vertically extending configuration before solidification so as to facilitate clamping of the upper flash of the article by an article removing device (80). The blow molding machine is also provided a capability of performing quality discrimination for discriminating a normal article and a defective article during a process between a stage of initiation of extrusion of the parison and a stage of removing the article so as to discharge the removed article to a normal article discharging destination (301) for a normal article and to a defective article discharging destination (303) for a defective article on the basis of the result of the quality discrimination. The blow molding machine (1) may also have a capability of deriving a relationship between a parison length of a resin to be used and a screw rotation speed of the extruder depending upon the resin to be used, and controlling the extruder screw rotation speed by calculating a correction amount for the extruder screw rotation speed according to the determined relationship between the parison length and the extruder screw rotation speed to attain the target parison length.

FIG.1



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The present invention relates to a method and system for removing with parison an article from a blow molding machine such as a machine for blow molding containers for detergents, decorative bottles or the like.

Also, the present invention relates to a method for controlling the length of a parison in a blow molding machine.

(A) Article Removing Method

Japanese Unexamined Patent Publication No. **50-111167** discloses a rotary blow molding machine for sequentially molding hollow resin articles employing a thermoplastic resin parison. Such rotary blow molding machine has a pair of rotary frames. Between the pair of rotary frames, a plurality of pairs (**8** pairs)of molds which can be opened and closed by means of a locking mechanism, are disposed. Though an extruder positioned above the pair of rotary frames, a parison is supplied to each pair of molds positioned beneath the extruder sequentially on a one-by-one basis. After clocking the mold the parison is sheared off the extruder by rotation of the pair of frames in a predetermined direction. After blow molding, each blow molded article is removed from the pair of opened molds by chucking flash thereof by a chuck of an article removing device.

However, in the above-mentioned conventional rotary blow molding machine, the parison supplied to the pair of molds is apt to be sheared off the extruder upon rotation of the pair of rotary frames. The flash at the upper end of the parison, which extends upwardly from the upper surface of the pair of molds, tends to fall down to the upper surface of the pair of molds so that it may be solidified in the fallen position to become the flash of the blow molding article. In such case, difficulty has been encountered in chucking such flash by the chuck of the article removing device.

Also, since the articles removed by the article removing device are discharged to downstream processes for quality discrimination, it is possible that defective articles will be supplied to the downstream processes.

(B) Parison Length Control Method

The blow molding machine performs blow molding by the processes of downwardly extruding the parison from the extruder, closing the end of the parison, injecting a blowing gas into the closed parison to expand the parison it has the configuration of the cavity.

To this end, the length of the parison extruded from the extruder has to be controlled to a constant length for the reasons ① ~ ③ set out below.

①The thickness of the parison extruded from the extruder is cyclically controlled at a regular interval toward a target parison length in order to provide desired thickness for the articles after blow molding. Accordingly, in order to obtain high precision thickness distribution of the article with the cyclically performed parison thickness control, it becomes necessary to accurately maintain a constant parison length at the time of closing the molds.

② When the length of the parison is excessive, the length of the lower end of the parison protruding from the molds becomes excessive, causing substantial loss of material.

③ When the parison is too short, it becomes difficult to clamp the lower end of the parison to the molds and makes blow molding impossible.

Therefore, in the prior art, proposals were made for controlling parison length, as disclosed in U. S. Patent **3,759,648** and Japanese Unexamined Patent Publication No. **51-41061.**

The method disclosed in U. S. Patent **3,759,648** performs discrimination whether the parison length is sufficiently long or too short by checking whether or not the parison reaches a position to block a light beam of a phototube unit. This is done with specific timing with respect to the clamping timing. Based on the results of this discrimination the screw rotation speed of the extruder is modified to ensure a given length of the parison in accordance with the clamping timing.

The method disclosed in Japanese Unexamined Patent Publication No. **51-41061** includes two sets of phototube units arranged below the extruder so as to discriminate regarding the length of the parison in such a manner that(a)when the light beams of both phototube units are not blocked by the parison, the decision is made that the parison length is too short, (b) when the light beam of only the upper phototube unit is blocked, the parison length is proper, and (c) when the light beams of both of the phototube units are blocked, the parison is too long. Based on these results the clamping timing is modified so as to ensure a constant length of parison in accordance with the clamping timing.

However, the prior art set forth above encounters the following problems ① ~ ③.

①In both U. S. Patent No. **3,759,648** and Japanese Unexamined Patent Publication No. **51-41061**, the relationship between the object to be monitored(parison length)and the variable to be controlled (screw rotation speed of the extruder or the clamping timing) is so indefinite that the control constant has to be determined on a trial-and-error basis. Therefore, it takes a long time to determine the optimal value. Furthermore, reproductivity of the control is rather poor.

②In both U. S. Patent No. **3,759,648** and Japanese Unexamined Patent Publication No. **51-**

41061, discrimination is made only as to whether the current parison is too long or too short, ignoring the offset magnitude from the target value (parison length difference). Therefore the control, depending upon parison length difference, cannot be performed to maintain precision level of control. In addition, when the offset magnitude is relatively small, it often causes hunting of the control and when the offset magnitude is relatively large the control takes a relatively long time.

③ In Japanese Unexamined Patent Publication No. **51-41061**, since the variable to be controlled is the timing of clamping, difficulty is encountered in synchronization of operation with the parison thickness control which is performed cyclically at a regular interval. This tends to cause degradation of precision of thickness distribution in the article. Furthermore, modification of clamping timing causes necessity of adjustment of operation timing and/or operation speed of the mechanical system and accordingly reduces the efficiency of the molding operation.

It is an object of the present invention to provide an article removal process assuring removal of articles with good discrimination between normal products and defective products for discharge to do this under sequential operations without interruption of the operations, and to do this at any time during the operation from molding start up to normal operation.

Another object of the invention is to provide a process which enables quick determination of control variables corresponding to the resin to be used or currently used, provides increasing precision of parison length control, achieves increasing precision of thickness distribution of articles, and offers ready adaption to high speed molding.

(A) Article Removing Method

According to an important aspect of the invention, there is provided an article removing process for a blow molding machine, in which a mold for clamping a parison is arranged below an extruder extruding the parison, the parison is cut above the upper surface of the mold so as to leave an upper flash on a molded article, comprising the steps of:

correcting the configuration of the upper end of the parison into a flat and vertically extending configuration before solidification;

performing quality discrimination for discriminating a normal article from a defective article during a step between the stage of initiation of extrusion of the parison and the stage of removing the article; and

chucking the upper flash at an article removing stage to discharge the removed articles to a normal article discharging destination for the normal article and alternatively discharging defective articles to a defective discharging destination on the basis of the result of the quality discrimination.

The article removing process inclodes the feature that the defective discrimination includes:

(a) means for judging whether the parison is defective upon initiation of molding operation;

(b) means for judging whether the parison is defective when its length is outside a target length range;

(c) means for detecting blowing gas supply failure during parison blowing;

(d) means for detecting failure of downstream facility following the blow molding machine;

(e) means for detecting absence of an article at the article removing station;

(f) means for detecting when lower flash of article is not present at a predetermined position at the article removing station;

(g) means for detecting abnormality when the article removing device erroneously holds an article; and

(h) means for detecting defects in articles molded by molds on which the absence of an article is detected in the above-mentioned item (e) in preceding cycle.

According to a still further aspect of the invention, there is provided an article removing system for a blow molding machine, in which a mold for clamping a parison is arranged below an extruder extruding the parison, wherein the parison is cut above the upper surface of the mold so as to leave an upper flash on a molded article, comprising:

a flash configuration correcting device provided above the mold and arranged to shape the upper end of the parison into a flat and vertically extending configuration before solidification of the parison;

an article removing device arranged to clamp an upper flash of the molded article and to remove the article from the mold; and

a defective discrimination control device for performing quality discrimination for discriminating between a normal article and a defective article during the process between a step of initiation of extrusion of the parison and the step of removing the article and controlling the article removing device to discharge the removed article to a normal article discharge destination for the normal articles and to a defective discharge destination for the defective articles, all on the basis of the results of quality discriminations.

According to a still further aspect of the invention, there is provided an article removing system for a blow molding machine in which a molds for clamping a parison is arranged below an extruder extruding the parison, the parison is cut above the upper surface of the mold so as to leave an upper flash on a molded article, comprising:

an article removing device provided above the mold and shaping the upper end of the parison into a

flat and vertically extending configuration before solidification of the parison, and clamping an upper flash of the molded article and removing the article from the mold; and

a defective discrimination control device for performing quality discrimination for discriminating a normal article and a defective article during a process between initiation of extrusion of the parison and removing the article and controlling the discharge of the removed articles to a normal article discharging destination for the normal articles and to a defective discharging destination for the defective articles, all on the basis of the result of the quality discrimination.

According to the present invention, the following effects (**1**) to (**4**) can be achieved.

(**1**) Since the shown embodiment shapes the upper end of the parison extending upwardly from the upper surfaces of the molds into a flat and vertically extending configuration before solidification, the upper flash can be certainly and readily chucked. Accordingly, removal of the articles can be assured and a continuous operation performed without stopping operation throughout initiation of molding to the normal operating condition.

(**2**) By discriminating between normal articles and defective articles during the stage between starting extrusion of the parison to removal of the article, normal articles are discharged to the destination for the normal produce (normal article discharging conveyer) and the defective articles are discharged to the destination for the defectives (defective discharging conveyer). Accordingly, not only in the molding process, but also in the article removing process, quality discrimination between the normal articles and the defective articles can be performed to accurately discharge the normal articles and the defective ones separately.

(**3**) By the above-mentioned effect (**1**), the defective articles upon initiation of the molding operation can be automatically discharged without stopping the machine. This enables automating the initial operation.

(**4**) By the above-mentioned effects (**1**) and (**2**), the defective articles in normal operation can be automatically taken out without stopping the machine to eliminate the necessity of re-starting the operation associated with stopping of the machine, and avoiding discharging of the defective articles to the downstream processes. Therefore, sequential molding can be achieved.

(B) Parison Length Control Method

According to still another aspect of the invention, there is provided a parison length control method for a blow molding machine, in which a parison is extruded from a extruder to hang, the end of the parison is closed and a blowing gas is blown into the closed parison. The method comprises the steps of:

preliminarily deriving a target relationship between a parison length of a resin to be used and the screw rotation speed of the extruder depending upon the resin to be used, during a test molding process;

detecting a current parison length during normal molding operation;

deriving a parison length difference between the current parison length and the target parison length;

controlling the extruder screw rotation speed by calculating a correction amount for the extruder screw rotation speed according to the preliminarily determined relationship between the parison length and the extruder screw rotation speed to attain the target parison length.

According to still another aspect of the invention, the parison length control method for a blow molding machine according to the foregoing aspect of the invention, further comprises a step of deriving a fluctuation of the current parison length over a relatively short period and setting a width of a deadband, in which deadband no correction of the extruder screw rotation speed is performed, all on the basis of the magnitude of the fluctuation.

According to yet another aspect of the invention, the parison length control method for a blow molding machine according to the above-mentioned aspects, features in that a period, in which a light is blocked by the parison, is measured by a phototube provided below the extruder and the measured period is used as a value corresponding to the current parison length.

In accordance with the invention, the following effects (**1**) to (**5**) are achieved.

(**1**) The control constant is calculated automatically. Accordingly, the control constant can be derived quickly without relying on the operator's trial and error, and thus provides good reproducing ability of the control.

(**2**) Since the control constant can be derived corresponding to the resin, it may provide high precision of control.

(**3**) Since the parison length is controlled on the basis of the error (parison length difference) between the current parison length and the target parison length, high precision can be provided for control. Also, since the control is performed depending upon the parison length difference, possibility of causing hunting can be reduced and the converging period can be shortened.

(**4**) Since the object of control is the extruder screw rotation speed and need not modify the timing of locking of the molds, synchronization to the parison thickness control which is performed cyclically with a constant interval can be facilitated. In addition, since the parison length can be

controlled to be constant, the thickness distribution of the article can be controlled with high precision.

(**5**) Since the locking timing of the molds is not necessarily modified, it is unnecessary to adjust the operation timing and the operation speed of the mechanical system to permit adaption for high speed molding.

According to the invention,the following effects (**6**) and (**7**) can be achieved.

(**6**) The deadband can be controlled on the basis of the data reflecting the fluctuation of the current parison length with respect to the molding device to be actually used. Therefore, the deadband can be controlled to the proper range to avoid hunting.

(**7**) The deadband can be calculated automatically. Accordingly, the deadband can be set quickly without requiring trial and error of the operator. Also, high reproducing ability can be achieved.

According to the invention, the following effect of (**8**) can be achieved.

(**8**) The current parison length is calculated from the light blocking period, making it possible to certainly and easily derive the parison length.

According to still another embodiment of the invention, there is provided a parison length control method for a blow molding machine, in which a parison is extruded from a extruder to hang, the end of the parison is closed and a blowing gas is blown into the closed parison, the method comprising the steps of:

detecting a current parison length during normal molding operation;

deriving a parison length difference between the current parison length and a target parison length and deriving a relationship between the parison length of a resin to be used and the screw rotation speed of the extruder; and

controlling the extruder screw rotation speed by calculating a correction amount for the extruder screw rotation speed according to the determined relationship to attain the target parison length.

According to still another aspect of the invention, the parison length control method for a blow molding machine according to the foregoing aspect of the invention, further comprises the step of deriving a fluctuation of the current parison length over a relatively short period and setting a width of a deadband, in which the correction of the extruder screw rotation speed is not performed, on the basis of the magnitude of the fluctuation.

According to still another aspect of the invention, the parison length control method for a blow molding machine according to the above-mentioned aspects, the period when light is blocked by the parison is measured by a phototube provided below the extruder and the measured period is used as a value corresponding to the current parison length.

With the above-mentioned aspects of the invention, the following effects of (**1**) to (**5**) are achieved.

(**1**) The control constant is calculated automatically. Accordingly, the control constant can be derived quickly without relying on the operator's trial and error, and thus provides high reproducing ability of the control.

(**2**) The control constant can be derived with respect to the current used resin, and especially depending upon the property variation of the resin in real time. Accordingly, high precision control can be achieved.

In addition, (a) since it becomes unnecessary to preliminarily perform tests to obtain the control constant, and since the control constant can be derived during the normal molding process, it becomes possible to save the resin and power required for testing. (b) Even when the die head comprising the die and core is modified for new resin and for new parison configuration, a normal molding operation for obtaining normal products can be directly initiated without performing the test process. (c) When the control constant derived through the test process is employed, it is possible that the control constant will fall outside the optimal value, due to variation of the property of the resin resulting from variation of the resin between lots, or due to variation of the mixture ratio of a recycled resin, to lower the precision of control. The present invention is adapted to derive the control constant from time to time, so that the control constant can be always maintained at the optimal value to permit optimal control.

(**3**) Since the parison length is controlled on the basis of the error (parison length difference) between the current parison length and the target parison length, high precision can be provided for control. Also, since the control is performed depending upon the parison length difference, possibility of causing hunting can be reduced and the converging period can be shortened.

(**4**) Since the object of control is the extruder screw rotation speed and not the timing of locking of the molds, synchronization to the parison thickness control which is performed cyclically with a constant interval can be facilitated. In addition, since the parison length can be controlled to be constant, the thickness distribution of the article can be controlled with high precision.

(**5**) Since the locking timing of the molds is not modified, it is unnecessary to adjust the operation timing and the operation speed of the mechanical system to permit adaption for high speed molding.

According to the invention, the following effects (**6**) and (**7**) can be achieved.

(6) The deadband can be set on the basis of the data reflecting the fluctuation of the current parison length with respect to the molding device to be actually used. Therefore, the deadband can be set at the proper range to successfully avoid hunting.

(7) The deadband can be calculated automatically. Accordingly, the deadband can be set quickly without requiring trial and error of the operator. Also, high reproducing ability can be achieved.

According to the invention, the following effect **(8)** can be achieved.

(8) The current parison length is calculated from the light blocking period, so that it becomes possible to certainly and easily derive the parison length.

The present invention will be understood more fully from the detailed description given herebelow and from the accompanying drawings of the preferred embodiment of the invention, which, however, should not be taken to be limitative to the present invention but are for explanation and understanding only.

In the drawings:

(A) Article Removing Method

Fig. 1 is a plan view of one embodiment of a rotary blow molding machine according to the present invention;

Fig. 2 is a side elevation of an extruder of the blow molding machine;

Fig. 3 is a front elevation of the extruder;

Fig. 4 is a back elevation of the extruder;

Fig. 5 is a plan view of a parison cutting device of the blow molding machine;

Fig. 6 is a section taken along line VI - VI of **Fig. 5**;

Fig. 7 is a partially sectioned side elevation of the parison cutting device;

Fig. 8 is a side elevation of a mold lock device of the blow molding machine;

Fig. 9 is a front elevation of a flash configuration correcting mechanism of the block molding machine;

Fig. 10 is a plan view of the flash configuration correcting mechanism;

Fig. 11 is a side elevation of an article removing device of the block molding machine;

Fig. 12 is a side elevation of an upper flash chucking removal mechanism of the article removing device of the blow molding machine;

Fig. 13 is a section taken along line XIII - XIII of **Fig. 12**;

Fig. 14 is a front elevation of the upper flash chucking removal mechanism;

Fig. 15 is a plan view of a draw-holding transportation mechanism of the article removing device;

Fig. 16 is a side elevation of the draw-holding transportation mechanism;

Fig. 17 is a front elevation of the draw-holding transportation mechanism;

Fig. 18 is an enlarged side elevation of the mold lock device;

Fig. 19 is a side elevation of another embodiment of an extruder;

Fig. 20 is a side elevation of a mold with a presealing device;

Fig. 21 is a section of the mold incorporating a blowing device and an ejector device;

Fig. 22 is a diagrammatic illustration showing an article removal control circuit;

Fig. 23 is a flowchart showing process of an article removal control;

Fig.24 is a diagrammatic illustration showing an article discharging route;

Fig. 25 is a front elevation of another embodiment of a reciprocation type block molding machine;

Fig. 26 is a side elevation of the block molding machine;

(B) Parison Length Control Method

Fig. 27 is a block diagram showing one embodiment of a parison length control system according to the present invention;

Fig. 28 is a flowchart showing a basic control process of the present invention;

Fig. 29 is a chart showing a relationship between a light blocking period of a parison and a rotation speed of a screw;

Fig. 30 is a flowchart for a process for determining a control constant representative of the relationship between a light blocking period of the parison and the screw rotation speed;

Fig. 31 is a chart showing a deadband;

Fig. 32 is a control chart showing a process for deriving a correction amount for the screw rotation speed based on the light blocking period of the parison;

Fig. 33 is a flowchart showing a process for deriving a correction amount for the screw rotation speed based on the light blocking period of the parison;

Fig. 34 is a flowchart showing another process for deriving a correction amount for the screw rotation speed based on the light blocking period of the parison;

Fig. 35 is a front elevation of a blow molding machine;

Fig. 36 is a side elevation of the blow molding machine;

Fig. 37 is a block diagram of one embodiment of a parison length control system according to the present invention;

Fig. 38 is a flowchart showing a basic control process of the present invention;

Fig. 39 is a chart showing a relationship between a light blocking period of a parison and a rotation speed of a screw;

Fig. 40 is a flowchart for a process for determining a control constant representative of the relationship between a light blocking period of the parison and the screw rotation speed;

Fig. 41 is a chart showing a deadband;

Fig. 42 is a control chart showing a process for deriving a correction amount for the screw rotation speed based on the light blocking period of the parison;

Fig. 43 is a flowchart showing a process for deriving a correction amount for the screw rotation speed based on the light blocking period of the parison;

Fig. 44 is a flowchart showing another process for deriving a correction amount for the screw rotation speed based on the light blocking period of the parison;

Fig. 45 is a front elevation of a blow molding machine; and

Fig. 46 is a side elevation of the blow molding machine.

In **Fig. 1**, the reference numeral **1** denotes a rotary type blow molding apparatus which includes an extruder **10** for extruding a tubular molten parison **2** of thermoplastic resin downwardly in vertical direction. A base **5** is provided in parallel to the extruder **10**. Six pairs of molds **8** and **8'** for performing blow molding by clamping the molten parison **2** are mounted on a turntable **7** via mounting plates **9**, which turntable **7** is, in turn, rotatably mounted on the base **5** for rotation about a support shaft **6** (see **Fig. 8**). Each of the six pairs of the molds **8** and **8'** are designed to be intermittently moved in the circumferential direction in order through stations A to F shown in **Fig. 1**, so that blow molding is sequentially performed for forming the molten parison **2** into an article **2'** such as a detergent container, decorative bottles or so forth, for example, during one cycle of circumferential movement around to the stations A to F (see **Fig. 11**).

As shown in **Figs. 1** to **4**, the extruder **10** essentially comprises a lower base **11**, an upper base **12** provided above the lower base **11** to be driven to rotate in horizontal direction relative to the lower base **11** by means of a rotatingly driving mechanism **20**, and an extruder body **13** provided above the upper base **12** and being adapted to be driven in vertical direction by means of a vertical driving mechanism **30** so as to supply the molten parison **2** to the pair of molds **8** and **8'** at the lowered position.

As shown in Figs. **1** to **4**, the extruder body **13** has a hopper **14** at the upper feed side thereof for supplying a pellet form thermoplastic resin (material). A screw **16** driven to rotate by a motor **15** or so forth is incorporated at the lower portion of the hopper **14**. The hopper **14** is also provided with a cylinder **18** which is adapted to be heated by a heating device (not shown). The thermoplastic resin molten in the cylinder **18** is simultaneously extruded downwardly as three tubular molten parisons **2, 2** and **2** into cavities defined in the pair of molds **8** and **8'** with mutually identical configuration, through a tubular extruding die heads **19** provided at the tip end of the cylinder **18**. It should be noted that the number of molten parisons to be extruded from the extruder body is not necessarily limited to three, but can be one, two or four, for example.

As shown in **Figs. 1** to **4**, the rotating driving mechanism **20** comprises guides **21** respectively fixed at the four corners of the upper surface of the lower base **11**, guides **22** fixed at four corners of the lower surface of the upper base **12** and slidable relative to the guides **21**, rotary ring bearing (inner bearing) **23** fixed to the upper surface of the lower base **11** and having internal teeth **23a**, and a motor **26** having a motor shaft **26a**, on which a drive gear **27** meshing with the internal teeth **23a** of the inner bearing **23** is fixed.

As shown in **Figs. 2** to **4**, the vertical driving mechanism **30** essentially comprises a pair of hinges **31, 31** provided between the rear portion of the upper base **12** and the rear portion of the extruder body **13**, a pair of shock absorbers **32, 32** disposed between the front portion of the upper base **12** and the front portion of the extruder body **13**, a pair of links **34, 34** pivoted at respective ends to a pair of brackets **33, 33** vertically extending from the front side of the upper surface of the upper base **12**, a link **36** pivoted at one end on a pair of brackets **35, 35** downwardly extended from the front side of the lower surface of the extruder body **13**, and a hydraulic cylinder **38** supported on a bracket **37** extending from the upper surface of the upper base **12** in vertically rockable fashion and having a rod **38a** with a channel shaped tip end receiving the other ends of the links **34, 34** and the other end of the link **36** for pivoting about a pivot pin.

As shown in **Figs. 5** and **7**, a parison cutting device **40** is adapted to cut the three molten parisons **2, 2, 2** supplied to the pair of molds **8** and**8'** arranged below the die head **19** into a predetermined constant length so that the upper ends **2a, 2a, 2a** slightly extend from the upper surface of the pair of molds **8** and **8'**. The parison cutting device **40** has a base plate **41** which is fixed to the extruder body **13** and extends horizontally below the front portion of the cylinder **18**, an air cylinder (actuator) **42** supported on the base portion of the base plate **41** in rockable fashion in the lateral direction by a support shaft **43** or so forth, a rotary plate **44** having a shaft portion **44a** engaged with a one-way clutch **46** fixed to the lower surface of the tip end of the base plate **41** by a bolt **45** and receiving the tip end of the rod **42a** of the air cylinder **42** for pivoting about a pin so as to be driven in one

direction (clockwise direction) by reciprocating movement of the rod **42a** toward and way therefrom, a mounting plate **47** fixed to the lower end of the shaft portion **44a** of the rotary plate **44**, a triangular cutter **48** mounted at the tip end thereof on the front portion of the upper surface of the mounting plate **47** by means of a plurality of bolts **49** or so forth, and a cutter positioning mechanism **50** provided on the base plate **41** together with the air cylinder **42** and the rotary plate **44** for determining a cutting start position (rotation start position). The cutter **48** is adapted to rotate in one direction instead of in reciprocation for cutting the upper ends **2a**, **2a**, **2a** of the molten parisons **2**, **2**, **2**. Therefore, the molten parisons **2**, **2**, **2** can always be cut in a constant condition, e.g. at the constant length. It should be noted that the upper ends 2a of the molten parison **2** are adapted to be left as an upper flash **2a'** (flash at the open end) at the upper portion of the molded article **2'** after blow molding.

As shown in **Figs. 5** and **6**, the cutter positioning mechanism **50** comprises a small size air cylinder **51** fixed on the base plate **41** in substantially parallel relationship with the air cylinder **42**, a pair of links **52**, **52** supported in a recessed portion **41a** of the base plate **41** on the base plate **41** in rockable fashion about a support shaft **53**, an intermediate link **54** pivotally connected at both ends to the central portion of the pair of links **52, 52** and the tip end **51a** of the rod of the air cylinder **51** for pivotal movement about pivot pins, and a roller **55** rotatably supported between tip ends of the pair of links **52, 52** via a support shaft **56** and freely contacting to and releasing from an arc shaped cut-out **44b** formed on the outer circumference of the rotary plate **44** for determining the cutting start position (rotation start position) of the cutter **48**.

The outer circumference of the lower surface of the turntable **7** which is rotatably on the base **5** via the support shaft **6** is mounted on a plurality of bearings **60** provided on the base **5**. Also, on the outer circumference of the turntable **7**, an annular driven gear **61** is fixed. A pair of idler gears **62, 62** rotatably supported on the base 5 via support shafts **63** are meshed with the driven gear **61**. The pair of idler gears **62, 62** are meshed with a drive gear **66** mounted on a reduction gear assembly **65** of an AC servo-motor **64** on the base **5.** The since the pair of idler gears **62, 62** are interposed between the drive gear **66** and the driven gear **61** of the turntable **7,** it becomes possible to remove backlash between the meshing gears so as to permit intermittent rotation and positioning upon stopping with high precision of the turntable **7**.

As shown in **Figs. 1** and **8**, a gate-like frame **67** is provided over the turntable **7** on the base **5** between the stations B and E on the turntable **7** on the base **5.** An article discharging device **68** for discharging the molded article **2'** removed from the molds is provided at the station F of the turntable **7** on the base **5**. At the position in the station B of the gate-like frame **67** of the turntable **7,** a flash configuration correcting mechanism **70** for correcting the upper end **2a** of the molten parison **2** projecting from the upper surface of the pair of molds **8** and **8'** into the flat and vertically extending configuration before solidifying. An article removing device **80** is provided between upper frame **68a** and an intermediate frame **68b** of the article discharging device **68** projecting above the turntable **7** therefrom, which article removing device **80** is adapted to remove the molded article **2'** upon opening of the pair of molds **8, 8'** after blow molding by lifting the article **2'** while chucking the upper flash **2a'**, and subsequently by drawing the upper flash **2a'** and holding the body **2b'**.

As shown in **Figs. 8** to **10**, the flash configuration correction mechanism **70** comprises four guide bolts **73 ...** fixed on brackets **71** by means of nuts **72** at the tip ends thereof. The brackets **71** are fixed on the gate-like frame **67** at the position above the position between the pair of molds **8, 8'** at the station B of the turntable **7.** The flash configuration correction mechanism **70** also includes a channel-shaped mounting plate **74** mounted on the lower ends of the guide bolts **73**, and a pair of clampers **76, 76** extending through a pair of guide bars **75, 75** and sliding thereon to shape the upper ends **2a, 2a, 2a** of the molten parisons **2, 2, 2** projecting upwardly from the upper surface of the pair of molds **8, 8'** into the flat and vertically extending configuration before solidifying. The flash configuration correcting device **70** is further includes a pair of air cylinders **77, 77** mounted at the center of the outer sides at both sides **74a, 74a** of the mounting plates **74.** The air cylinders **77, 77** have rods **77a** fixed to the center of respective clampers **76** for operating the latter toward and away from each other. Cooling means may be provided on the pair of clampers **76, 76** for promoting solidification of the upper end **2a** of the molten parison **2**.

As shown in **Fig. 11**, the article removing device **80** is arranged on the upper frame **68a** of the article discharging device **68**. The article removing deice **80** comprises an upper flash chucking removal mechanism **81** for lifting with chucking the upper flash **2a'** of the article **2'** upon opening of the pair of molds **8, 8'**, and a drawing and holding transportation mechanism **90** for drawing the upper flash **2a'** and holding the body **2b'** of the article **2'** removed by the upper flash chucking removal mechanism **81**, and rotating for **180°** to transfer the article **2'** to the article discharging device **68**.

As shown in **Figs. 11** to **14**, the flash chucking removal mechanism **81** includes an air cylinder **82** extending from the tip end of the upper frame **68a** of the article discharging device **68**. A mounting plate **83** is fixed to the tip end of a rod **82a** of the air cylinder **82** for vertical movement according to expansion and contraction of the rod **82a.** The mounting plate **82** is formed into an essentially channel shaped configur-

ation. A pair of chucks **85, 86** extend through a pair of guide shafts **84, 84** extended over both ends **83a, 83b** of the mounting plate **83** and slide therethrough for chucking the upper flash **2a'** of the article **2'** for removing the same from the pair of molds **8, 8'** opened. An air cylinder **87** has a rod **87a** with the tip end fixed to the center of one of the chucks **86**. A pair of air cylinders **88, 88** are mounted on both sides of the outer surface of one side portion **83a** of the mounting plate **83** and have rods **88a** fixed to both sides of the other chuck **86** so as to contact and release three chucking pieces **89** of the other chuck **86** to and from the one chuck **85**. By movement of the rods **87a, 88a** of respective of the air cylinders **87, 88**, the upper flash **2a'** of the article **2'** is chucked to remove the article **2'** upon opening of the pair of molds **8, 8'** by the action of the rod **82a** of the air cylinder **82**, to lift the article to the predetermined position beneath the upper frame **68a** of the article discharging device. It should be noted that cooling means may be provided on the chucks **85, 86**.

As shown in **Figs. 11** and **15** to **17**, the drawing and holding transportation mechanism **90** includes a pair of arms **91, 91** to be driven to rotate over **180°** by a motor **92** provided on the intermediate frame **68b** of the article discharging device **68**, a sliding frame **94** slidable in the longitudinal direction along a pair of guide shafts **93, 93** provided at both side portions of the front ends of the arms **91**, an air cylinder **95** having a rod **95a** fixed to the slide frame **84** at the tip end to drive the slide frame **94** in the longitudinal direction by expansion and contraction of the rod **95a**, three drawing pads **96** mounted on the front surface of the upper portion of the slide frame **94** with a regular interval and adapted to draw the upper flash **2a'** of the article **2'**, three pairs of gripping pieces **97, 97** mounted on the front surface of the lower portion of the sliding frame **94** for holding and releasing the body **2b'** of the article **2'** by means of an air cylinder **98.** It should be noted that, in **Fig. 11**, the reference numeral **99** denotes a proximity switch. By the proximity switch **99**, the angular positions of the pair of arms **91, 91** can be controlled so that they are placed in relation to the drawing pads **96** and the pairs of the gripping pieces **97, 97** provided on the respective front ends of the arms **91, 91** above the opened molds **8, 8'** and above the article discharge device **68**.

The six pairs of molds **8, 8'** arranged on the turntable **7** via six base plates **9** with an internal of **60°** can be opened and closed by means of a mold lock device **100** as shown in **Figs. 8, 18**. The mold lock device **100** comprises a pair of guide shafts **101, 101** fixed by three support blocks **102** extending from the center portion of the base plate **9** with a regular interval in horizontally parallel relationship to each other, a pair of movable plates **103, 103'** provided slidably along the pair of guide shafts **101, 101** and fixed thereon the pair of molds **8, 8'** on the mutually opposing surfaces, a pair of clamping rods **104, 104'** connected to the back sides of the movable plates **103, 103'** for driving the molds toward and away from each other, a rockable lever **105** rockably supported on a bracket **106** extending from one end (outer side) of the base plate **9** for rocking about a pivot **107** provided at the lower elevation than the height of the guide shafts **101, 101**, having an upper end, to which the other end of one clamp rod **104'** is pivotally connected via an intermediate link **108** and a lower end extending downwardly from the upper surface of the base plate **9** through an opening portion **9a**, a slide rod **110** supported slidably below the base plate via a pair of blocks **109, 109** and connected at one end to the lower end of the rockable lever **105** distanced from the pivot shaft **107** equal to a distance between the pivot shaft **107** and the intermediate link **108** pivoted at the other end of the clamping rod **104'**, a connecting plate **112** connected to the respective ends to the ends of the slide rod **110** and the other clamping rod **104** through the opening portion **9b** of the base plate **9** and slidable along a bracket extending from the other end (inner side) of the base plate **9**, and a toggle mechanism **120** reciprocally driving the connecting plate **112** by means a pair of hydraulic cylinders (actuators) **114, 115** downwardly provided at the positions of the gate-like frame **67** corresponding to the stations A and F so that the connecting plate **112** is driven forward by one of the hydraulic cylinders **114** to close the pair of molds **8, 8'** and hold in place and the connecting plate is driven backward by the other hydraulic cylinder **115** to open the pair of molds **8, 8'** and hold in place.

The toggle mechanism **120** comprises a first link **121** supported by the bracket **113** extending from the other end (inner side) of the base plate **9** via a support shaft **122** for pivotal movement in the vertical direction and being urged by the other hydraulic cylinder **115** at one end to kick the other end upwardly, and a second link **123** pivoted at the other end of the first link **121** at the intermediate portion, pivoted to the connecting plate **112** and slidable along an opening portion **113a** of the bracket **113** so as to drive the connecting plate **112** backward when the other end of the first link **121** is kicked up, and carrying a roller **124** rotatably supported on one end so as to be depressed onto the hydraulic cylinder when the other end of the first link is kicked up.

Turning now to the process of operation of the shown embodiment, the rotary type blow molding machine **1** is provided for performing blow molding with the molten parison **2** while the pair of molds **8, 8'** are driven to intermittently rotate from the station A to the station F.

At first, the pair of molds **8, 8'** which is opened to allow removal of the articles **2'** by the article removing device **80** at the station F, as shown in **Fig. 18**, are rotated to rotate to reach the station A. The AC servo-

motor **64** is stopped to stop the pair of molds **8, 8'** at the station A. The molds **8, 8'** are locked with clamping relative to the molten parisons **2, 2, 2** which have already been extruded to a given length, by means of the mold lock device **100**. Namely, the roller **124** of the second link **123** of the mold lock device **100** is depressed downwardly by means of the hydraulic cylinder **114** to move (forward) the connecting plate **112** outwardly (radially outward of the turntable **7**) on the base plat **9**. Then, the connecting plate **112** is moved (forward) toward the outside (radially outside of the turntable **7**). By the forward movement of the connecting plate **112,** one clamping rod **104** depresses one mold **8** toward the closing direction. At the same time, the clamping rod **104'** is driven to move in the opposite direction to that of the one clamping rod **104** via the slide rod **110**, the intermediate link **111**, the rockable lever **105** and the intermediate link **108** to depress the other mold **8'** toward the closing direction. By this, the pair of molds **8, 8'** are momentarily closed with clamping of three molten parisons **2, 2, 2.** At substantially the same timing as the locking the pair of molds **8, 8'**, the cutter **48** is driven to rotate at high speed in one direction (clockwise direction) as indicated by the arrow in **Fig. 5**, by reciprocal movement of the rod **42a** of the air cylinder **42** of the parison cutting device **40** to cut the parisons **2, 2, 2.** Since the cutter **48** is pivoted in one direction by a one-way clutch **46** to cut the parisons **2, 2, 2**, the parisons **2, 2, 2** can always be cut at a constant condition, for example at a constant length. Thus, monitoring of the cut length of the molten parisons **2, 2, 2** and a feedback control through processing of the monitored data can be facilitated. Also, the cutting start position of the cutter **48** can always be positioned at the position indicated by solid lines in **Fig. 5** by the cutter positioning mechanism **50**, the effect of cutting the molten parison **2, 2, 2** at the constant length can be enhanced.

At substantially the same timing, the extruder body **13** of the extruder **10** at the side of the die head **19** is pivoted upwardly about the hinge **31, 31** by the vertical drive mechanism, as shown in **Fig. 2.** By this, when the pair of molds **8, 8'** are rotated to move to the next station B, interference will never been caused between the pair of molds **8, 8'** and the molten parisons **2, 2, 2** being extruded from the die head **19**. When the pair of molds **8, 8'** are rotated to the position where no interference with the molten parisons **2, 2, 2** may be caused, the rod **38a** of the hydraulic cylinder **38** of the vertical drive mechanism **30** is retracted to pivot the extruder body **13** of the extruder **10** at the side of the die head **19** downwardly by the action of rod **38a** of the hydraulic cylinder **38** of the vertical drive mechanism **30** about the pair of hinges **31, 31** as shown in **Fig. 2.** Extrusion of the molten parisons **2, 2, 2** is maintained so as to provide the given length of the molten parisons **2, 2, 2** extruded when the next pair of the molds **8, 8'** is stopped at the station A.

Then, by driving the AC servo-motor **64** while maintaining the pair of molds **8, 8'** at locked position, the molds **8, 8'** are transferred from the station B to the station E through intermittent rotation over **60**° and stopping at respective stations. During this, compressed air is blown into the molten parisons **2** clamped within the pair of molds **8, 8'** through the blow needles incorporated in the molds **8, 8'** to blow mold the desired configuration of the hollow articles, After forming, the articles **2'** are cured or cooled within the pair of molds **8, 8'**.

In such pair of molds **8, 8'**, since blow needles instead of blow pins are employed in the compressed air blowing device, it is not possible to remove the articles **2'** from molds **8, 8'** with the blow pins after molding. Therefore, at the station B, the upper ends **2a, 2a, 2a** of the molten parisons **2, 2, 2** slightly extending from the upper surface of the pair of mold **8, 8'** are modified in configuration to be a flat and vertically extending configuration by the flash configuration correcting mechanism **70** by clamping the upper ends **2a, 2a, 2a** of the molten parisons **2, 2, 2** with a pair of clampers **76, 76**. This facilitates removal of the article **2'** from the pair of molds **8, 8'** by the later-mentioned article removing device **80**.

The turntable having a large diameter (such as **2700** mm) and heavy weight (such as **10** tons) can be driven through each of the zones between the stations A to F at high speed (e.g. **2.5** sec) for intermittent rotation (e.g. **1.6** sec. for rotation over each **60**° zone and for **0.9** sec. for stopping at each respective station), by the turntable drive device comprising the AC servo-motor **64**, the drive gear **66**, the pair of idler gears **62, 62**, the driven gear **61** and so forth. Thus, the pair of molds **8, 8'** are intermittently rotated to stop at the respective stations in order. Since the pair of idler gears **62, 62** are interposed between the annular driven gear **61** fixed to the outer periphery of the turntable **7** and the drive gear **66** to transmit the rotation of the AC servo-motor **64**, backlash between the gears can be eliminated. By this, rotation and positioning upon stopping of the turntable can be done with high precision.

When the pair of molds **8, 8'** reaches the station F, the pair of chucks **85** and **86** of the flash chucking removal mechanism **81** of the article removing device **80** are already placed at the lowered position. The upper flash **2a'** of the article **2'** which is shaped into the flat and vertically extending configuration by the flash configuration correcting mechanism **70** and projected from the upper surface of the pair of molds **8, 8'** can be chucked by each of the chucking pieces **89** and the chuck **86**. Substantially in conjunction with chucking, the mold lock device **100** is actuated by the hydraulic cylinder **115** to open the molds **8, 8'**. Then, by retracting the rod **82a** of the air cylinder **82** of the flash chucking removal mechanism **81**, the pair of chucks

85, **86** are lifted up to the drawing and holding transportation mechanism **90.** By lifting of the articles **2'** by the flash chucking removal mechanism **81**, then the drawing pads **96** provided on one arm **91** of the drawing and holding transportation mechanism **90** catch with certainly the upper flashes **2a'** of the articles at the position immediately below the chucks **85, 86** with vacuum, as shown in **Fig. 11**. Also, the body **2b'** of the articles **2'** are held by the pair of gripping pieces **97, 97** without causing vibration of the articles **2'**. Then, the arms **91** are driven to pivot over **180**° by the motor **92.** Thereafter, releasing drawing and holding condition, the completed articles **2'** can be discharged into the article discharging device **68**.

Opening of the pair of molds **8, 8'** by the mold lock device is achieved by moving(backward)the connecting plate **112** in the opposite direction to the locking direction. The pivot shaft **107** of the rockable lever **105** of the mold lock device **100** is positioned below the pair of guide shafts **101, 101.** The distance from this pivot shaft **107** to the pivot point of the intermediate link **108** at the other end of the clamping rod **104'** is set to be equal to the distance between the pivot shaft **107** to the pivot point of the intermediate link **111** of the slid block **110.** The pivot shaft **107** is positioned at the intermediate position between the positions of the pair of guide shafts **101** and the upper surface of the base plate **9**, the locking force of the mold lock device **100** can be equally distributed to the pair of guide shafts **101**, **101** and the base plate **9**. Therefore, no excessive load will be applied to the base plate **9** or so forth. In addition, the pair of molds **8**. **8'** can be held at the open and closed positions by the simple construction of the toggle mechanism **120** comprising the first link **121** and the second link **123.**

On the other hand, when the screw **16** of the extruder **10** is to be withdrawn for the purpose of cleaning after completion of the blow molding by the rotary type blow molding machine **1**, the extruder body **13** of the extruder **10** can be pivoted over a given angle by the pivoting drive mechanism **20** with respect to the turntable **7** as shown by the two dotted line of **Fig. 1**. By this, the extruder body **13** may not interfere with the mold lock device **100** or so forth so as to facilitate cleaning of the screw **16** or so forth. Furthermore, since the extruder body **13** is pivotable, the installation space for the rotary type blow molding machine **1** can be reduced.

It should be noted that, although the extruder **10** of the rotary type blow molding machine **1** is adapted to pivot in a vertical direction about the hinges **31, 31** by the vertical drive mechanism **30** in the shown embodiment, the extruder **10** is not limited to the shown construction. In the extruder **10'** in another embodiment of **Fig. 19**, the position of the pair of hinges **31'**, **31'** may be set substantially equal to the height of the die head **19** via the reversed V-shaped frame **3** (on the same horizontal plane). By this, the problem of variation of the die head **19** and the centering error of the parison **2** can be successfully avoided. It should be noted that, since other constructions of **Fig. 19** are identical to those of the former embodiment, the same components are represented by the same reference numerals and detailed discussion therefor is unnecessary.

Next, the blow molding process to be performed by the above-mentioned blow molding machine will be discussed herebelow.

The blow molding machine **1** includes the extruder **10** for extruding the parison **2** downwardly, a pre-sealing device **200** for pre-sealing one end portion of the parison **2**, a pre-blowing device **201** incorporated within the die head **19** of the extruder **10** for pre-blowing the compressed air into the pre-sealed parison **2**, the pair of molds **8**, **8'** for clamping the parison and closing both ends of the parison **2**, and a blowing device **202** incorporated in the mold **8** for blowing the compressed air into the parison **2** closed in the molds **8, 8'** until the parison becomes shaped to a consistent configuration with the cavity of the molds **8**, **8'**.

In the blow molding machine **1**, the parison **2** extruded from the extruder **10** is hung downwardly. One end of the parison **2** is clamped by the pre-sealing device **200** for pre-sealing. Then, the compressed air is pre-blown into the parison **2** by the pre-blowing device **201**. Subsequently, by clamping the parison **2** by the pair of molds **8**, **8'**, both ends of the parison are closed. The compressed air is blown into the closed parison **2** until the configuration becomes coincident with the cavity of the pair of molds **8**, **8'** to blow mold the article **2'**. The molded article **2'** is cooled within the molds **8**, **8'**. In **Fig. 21**, the reference numeral **230** denotes a cooling water passage defined within the molds **8, 8'**.

As shown in Figs. **20(A)** and **20(B)**, the blow molding machine is provided with the pre-sealing device **200** at the lower ends of the pair of molds **8, 8'**. The pre-sealing device **200** has a pair of pre-sealing plates **203, 203'** arranged projecting frontwardly from the mating surfaces of the molds **8**, **8'** and compression springs **204, 204'** resiliently supporting the back of the pre-sealing plates **203**, **203'**. By this, the pre-sealing device **200** clamps one end of the parison **2** with the pre-sealing plates **203, 203'** at the intermediate timing in the closing process of the molds **8**, **8'** for pre-sealing. On the other hand, the blow molding machine defines the compressed air discharge opening **205** of the pre-blowing device **201** at the center of the die head **19** of the extruder **10** to normally discharge the compressed air through the compressed air discharge opening **205**. Therefore, when one end of the parison **2** is pre-sealed by the pre-sealing device **200** as set forth above, the compressed air supplied by the pre-blowing device **201** expands the entire body of the parison **2** to form a space between two parison skin. The space prevents the blowing needle **210** of

the blowing device **202** from passing through both parison skins in the cavity of the molds **8, 8'** to make blow molding impossible in the subsequent process.

Namely, in the blow molding machine, the pre-sealing of the parison **2** is to be done at the lower portion of the molds **8, 8'**, namely at the position most distanced from the extruder **10.** Accordingly, the parison **2** will not be subjected to a strong bending effect at the position immediately below a die **19A** and a core **19B** of the die head **19** of the extruder upon pre-sealing so that a ring mark will never be formed. Therefore, the lower flash to be cut at the lower end of the parison **2** can be made smaller to improve yield.

On the other hand, in the blow molding machine, the parison **2** is extruded in a length corresponding to the overall length of the article to be molded upon performing pre-sealing for the parison **2**. The parison **2** is expanded uniformly through the entire body by the pre-blowing of the compressed air. Therefore, the pre-blow can be performed throughout all processes of the extrusion of the parison **2.** Before pre-sealing, the pre-blown compressed air passes the entire length of the parison and is discharged therefrom. On the other hand, once the parison **2** is pre-sealed, the pre-blown compressed air serves for expanding the entire body of the parison. Accordingly, it becomes unnecessary to monitor the timing for starting pre-blow to permit simplified pre-blow control.

Furthermore, as shown in Figs. **21(A)**, **21(B)**, **21(C)**, the blow molding machine **1** incorporates the blow needle **210** and a blow needle drive section **211** in the mold **8** mounted on the movable plate **103** serving as a mold mounting plate. Namely, the guide block **212** is integrally provided at the back side portion corresponding to respective cavities of the mold **8.** The blow needle drive section **211** is integrated with the guide block **212.** The blow needle drive section **211** includes an air cylinder **213** and a piston rod **214.** The base end of the blow needle **210** is connected to the piston rod **214.** The blow needle drive section **211** is designed to switch the position of the blow needle **210** between a projected position (see **Fig. 21**(B)) projecting into the cavity and a retracted position (see **Figs. 21**(A) and **21**(C)) retracted from the cavity by selectively switching the compressed air supply through a needle projecting port **213a** and a needle retracting port **213b** of the air cylinder. When the blow needle **210** is set at the projected position, an air induction port **215** defined in the guide block **212** communicates with an air passage **216** defined at the center portion of the blow needle **210.** When the blow needle **210** is set at the retracted position, an air discharge port **217** defined in the guide block **212** communicates with the cavity space via a needle hole **218** defined in the mold **8.**

Accordingly, in the shown construction of the blow molding machine, (**1**) when the molds **8, 8'** are open and the parison **2** is inserted between the mating surfaces of the molds **8, 8'**, the blow needle drive section 2**11** sets the blow needle **210** at the retracted position, (**2**) when the pair of molds **8, 8'** are locked, the blow needle drive section **211** sets the blow needle **210** at the projected position of **Fig. 21**(B) so that the blow needle **210** pierces one of the parison skins of the pre-blown parison **2** by the tip end thereof to introduce the compressed air supplied through the air induction port **215** into the parison **2.** Blowing of the compressed air by means of the blow needle **210** is continued until the configuration of the parison **2** becomes coincident with the cavity of the molds **8, 8'** and further until the formed parison is cooled. (**3**) Immediately before opening of the mold **8, 8'**, the blow needle drive section **211** moves the blow needle **210** to its retracted position so as to discharge the high pressure air in the molded article through the hole formed by piercing the needle, and through the needle guide hole **218(Fig. 21**(C))and the air discharge port **217** to prevent deformation of the molded article **2'** due to high pressure air in the article **2'** upon opening of the molds **8, 8'**.

On the other hand, as shown in **Figs. 21**(A), **21**(B), **21**(C), the blow molding machine incorporates an ejector pin **221** of an ejector device **220** and an ejector pin drive section **222** in the molds **8, 8'**. Namely, at both of upper and lower ends of the molds **8, 8'**, air cylinders **223** of the ejector drive section **222** are incorporated. The piston rods of the air cylinders **223** form ejector pins **221**. The ejector drive section **222** switches the position of the ejector pins **221** between a stand-by position (see **Figs. 21**(A) and **21**(B)) retracted from the upper and lower mating surfaces of the molds **8, 8'** and an active position (see **Fig. 21**(C)) projected from the mating surfaces of the molds **8, 8'** by selectively supplying the compressed air through a pin projecting port **223a** and a pin retracting port **223b** of the air cylinder **223**. The reference numeral **224** denotes a guide pin hole defined in the molds **8, 8'**.

By this, in the blow molding machine **1**, upon removal of the article with opening the pair of molds **8. 8'**, the ejector drive section **225** drives the ejector pin **221** to project from the mating surfaces of the molds **8, 8'** to hold the upper flash of the article **2'** with the pair of ejector pins **221** provided at the upper end side of the molds **8, 8'**, and a lower flash of the article **2'** is held between the pair of ejector pins **221** provided at the lower end side of the molds **8, 8'** to enable removal of the article **2'** from the molds **8, 8'**, as shown in **Fig. 21(C)**.

The shown embodiment of the blow molding machine is further provided with a defective discrimination control device **300**, as shown in **Fig. 22**. The defective discrimination control device **300** performs quality discrimination of the articles **2'** during the process from starting of extrusion of the parison by the extruder **10** to removal of the article by the article

removing device **80**. The defective discrimination control device **300** controls the article removing device **80** at the article removing stage so as to drop the normal articles to a discharge conveyer **301** of the article discharging device **68** and to direct the defective articles to the defective discharge conveyer **303** via a defective discharge chute **302** of the article discharge device **68**.

The layout of the normal article discharging conveyer **301** of the article discharging device **68**, the defective articles discharging chute **302** and the defective articles discharging conveyer **303** may be as illustrated in **Fig. 24.** The defective articles discrimination control device **300** monitors the instantaneous position of the arm **91** detected by an arm position detector **304** during pivotal movement of the arm **91** with the drawing pads **96** and the gripping pieces **97** by the motor **92** of the drawing and holding transportation mechanism **90** forming the article removing device **80** to selectively feed that articles in such a manner that, ① when the article **2'** is a normal product, the defective discrimination control device **300** controls a drawing pad driver **305** to release drawing of the drawing pads **96** of the upper flash **2a'** on the article **2'** and controls a cylinder driver **306** for the air cylinder **98** of the gripping pieces **97** to release gripping of the gripping pieces of the body **2b'** of the article **2'** at a timing where the drawing pads **96** and the gripping pieces **97** reach the position above the normal article discharging conveyer **301** through **180**° of pivotal movement, to discharge to the normal article discharging conveyer **301** and ② when the article **2'** is defective, the defective discrimination control device **300** controls the drawing pad driver **305** to releasing drawing of the drawing pads **96** for the upper flash **2a'** of the article **2'** and controls the cylinder driver **306** to release gripping of the body **2b'** of the article **2'** by the gripping pieces **97** at a specific timing mid-way of pivotal movement through **180**° of the drawing pad **96** and the gripping pieces **97** to divert the defective articles into a defective articles receptacle port **302** of the defective articles discharging chute by centrifugal force on the defective articles.

Here, in the shown embodiment, the defective articles discrimination control device **300** discriminates between the normal products and the defective products with respect to the following items (a) through (h).

(a) Item to detect that Parison 2 is Defective upon Initiation of Molding Operation

Upon initiation of molding operation, until the extruder screw rotation speed of the extruder **10** driven by the motor **15** is sufficiently accelerated and becomes constant, the length of the parison **2** extruded by the die head **19** at the locking timing should be shorter than the proper length. An article **2'** molded with such a parison is defective.

The defective discrimination control device **300** receives an output from the screw rotation speed detector **311** for detecting the rotation speed of the motor **15.** The defective discrimination control device **300** continuously outputs a defective indicative signal until the extruder screw rotation speed represented by the screw rotation speed detector **311** reaches a target speed preset through an input device **310.**

(b) Item to detect that Parison **2** is Defective When Length Thereof is outside the Target Length Range

The thickness of the parison extruded from the extruder **10** is cyclically controlled with respect to a target parison length in order to provide a desired thickness distribution in the article after blow molding. Accordingly, in order to obtain high precision of the article thickness distribution by the cyclically activated parison thickness control, it is essential to maintain a constant parison length at the locking timing of the molds. On the other hand, if the parison length is excessive, the length of the lower end extending from the molds **8**, **8'** to become the flash becomes excessive and this causes substantial wasting of the material, When the parison length is too short, the lower end of the parison cannot be clamped by the molds **8**, **8'** and this makes blow molding impossible.

Therefore, in the shown embodiment of the blow molding machine **1**, a phototube **312** is arranged beneath the die head **19** of the extruder **10** (see **Figs. 1** and **10**) to enable detection of the timing of blocking a light beam by the parison **2**. Signals indicating the cutting timing of the parison **2** by the cutter **48** of the parison cutting device **40** and the light beam blocking timing by the parison **2** passing across the phototube **312** are supplied to a parison length detector **313.** The parison length detector **313** derives a difference of the parison cutting timing and the light blocking timing of the parison as a light blocking period and derives the length of the parison **2** upon locking of the molds based on the light blocking period of the parison **2.** The defective article discrimination control device **300** receives the result of this detection by the parison length detector **313** to output a defective article indicative signal when the parison length is outside the target length range preset through the input device **310**.

(c) Item to Make Judgment of Blowing Gas Supply Failure during Parison Blowing

When the pair of molds **8**, **8'** are closed and the compressed air is blown into the parison **2** by the blow needle **210**, the article **2'** is judged as defective due to formation of a hole in the parison **2** if the compressed air is blown over an excessive period or the

air pressure drops below a predetermined pressure.

The defective article discrimination control device **300** is associated with a blowing air flow meter **314** and a blow air pressure detector **315** within an air supply path. The defective article discrimination control device **300** is responsive to the result of detection of the blow air flow meter **314** to output the defective article indicative signal when the blowing air flow meter continues detection of air flow beyond a given period or when the blowing air pressure is lower than a preset pressure of the input device **310**.

(d)Item to detect Failure of Downstream Facility following the Blow Molding Machine **1**

When the article **2'** is removed be the article removing device **80** and discharged to the downstream process and when the downstream facility, such as deflashing machine or so forth, is not operating in the normal state, secondary trouble may be caused by discharging the article **2'** to the downstream process.

Therefore, the defective article discrimination control device **300** receives an output of a downstream facility failure detector **316** to output the defective indicative signal irrespective of the quality, normal or defective, of the article **2'** <u>per se</u> if an abnormality is detected in the downstream process upon discharging the article **2'** removed by the article removing device **80**.

(e) Item to Make Judgement of Failure for Absence of Article **2'** at Article Removing Station

The blow molding machine **1** includes an article detector **317** comprising a phototube or so forth, at a station to remove the article **2'** from the molds **8**, **8'** by the article removing device **80** (see **Fig. 11**).

The defective article discrimination control device **300** issues the defective article indicative signal when the article **2'** which should be present, is absent when the article detector **317** fails to detect the presence of the article **2'** at a timing where the article removing device **80** removes the molded article.

(f) Item to detect of Defective Article When Lower Flash **2c'** of Article **2'** is not Present at Predetermined Position at Article Removing Station

The blow molding machine **1** includes a lower flash detector **318** comprising a phototube or so forth at the article removing station where the article **2'** is removed from the molds **8**, **8'** by the article removing device **80** (see **Fig. 11**).

The defective article discrimination control device **300** issues the defective article indicative signal when the lower flash detector **318** detects absence of the lower flash **2c'** at the predetermined position at the timing of removal of the article by the article removing device **80**. When the lower flash **2c'** of the article **2'** is not present at the predetermined position due to swaying or so forth, such lower flash **2c'** tends to be a cause of abnormality by blocking of the discharge path by falling down in the downstream process.

(g) Item to detect for Abnormality When Article Removing Device **80** Abnormally Holds Body **2b'** of Article **2'**

The article removing device **80** is provided with an article holding detector **319** on the air cylinder **98** for detecting opening and closing positions of the pair of gripping pieces **97** driven by the air cylinder **98** for holding the body **2b'**. The article holding detector **319** detects the opening and closing angle of the gripping pieces **97** by detecting the stroke position of the air cylinder **98** for detecting abnormal holding of the body **2b'** based on whether the gripping pieces **97** are, or are not, at the proper position at the cylinder stroke position to hold the body **2b'**.

The defective article discrimination control device **300** obtains the result of detection by the article holding detector **319** at the article removing timing to make judgement that part of the body **2'** of the article **2'** is crushed when the gripping pieces **97** holds the body **2b'** at a position at the closing side out of the proper position to issue the defective indicative signal.

(h) Item to detect Absence of Article **2'** in the above-mentioned Item (e) in Preceding Cycle

When the article **2'** is not present at the article removing station in the above-mentioned item (e), there is a possibility that the article **2'** was left un-removed from the corresponding molds **8**, **8'** to enter into the next cycle of process.

Therefore, the defective article discrimination control device **300** makes judgement of the possibility of producing redundantly molded articles with respect to the article **2'** molded in the next molding cycle of the same molds **8, 8'** and serves to output the defective article indicative signal.

Namely, in the defective article discrimination control device **300,** discrimination for normal articles and defective articles is made for all items of (a) to (h) through the overall process from starting of extrusion of the parison to the stage of the removing the article. Based on the results of discrimination studies, the defective article discrimination control device **300** controls the article removing device **80** at a timing of arrival of the molded article **2'** to the article removing station to feed the normal articles to the normal article discharging conveyer **301** and to put the defectives to the defective discharging conveyer **303** through the defective discharging shoot **302**.

The effect of the shown embodiment will be discussed herebelow.

(**1**) Since the shown embodiment shapes the upper end of the parison extending upwardly from the upper surface of the molds **8**, **8'** into a flat and vertically extending configuration before solidification, the upper flash **2a'** can be certainly and readily chucked. Accordingly, removal of the articles **2'** can be assured in the continuous operation performed without stopping the operation throughout initiation of molding to the normal operating condition.

(**2**) By discriminating the articles **2'** between normal and defective during starting of extrusion of the parison to the stage of removal of the finished article, the normal article is discharged to a destination for the normal product (normal article discharging conveyer) and the defective article is discharged to the destination for the defective articles (defective article discharging conveyer). Accordingly, not only in the molding process, but also in the article removing process, quality discrimination for the normal articles and defective articles can be performed to accurately discharge the normal articles and the defective articles in separated fashion.

(**3**) By the above-mentioned (**1**), the defective articles upon initiation of molding operation can be automatically discharged without stopping the machine to enable automating initial operation.

(**4**) By the above-mentioned (**1**) and (**2**), the defective articles in normal operation can be automatically taken out without stopping the machine to eliminate the necessity of re-starting the operation associated with stopping of the machine with avoiding discharging of the defective articles to the downstream processes. Therefore, sequential molding can be achieved.

It should be noted that, in the shown embodiment of the invention, the item for discriminating the defective articles can be at least one of the above-mentioned items (a) to (h). Also, it is possible to employ items other than the foregoing (a) to (h).

In **Figs. 25** and **26**, the reference numeral **400** denotes a reciprocation type blow molding machine which includes an extruder **401**, a mold **402**, an article removing device **403**, a defective discharging device **404** and a normal article discharging device **405**.

The extruder **401** includes a hopper **406**. The extruder also includes a cylinder **409** incorporating a screw to be driven to rotate by a motor **407** via a gear case **408** for extruding a tubular molten parison of a thermoplastic resin through an extrusion head **410**.

The mold **402** can be open and closed with a support provided by a mold lock device **402A**. The mold **402** is reciprocated obliquely in an up and down direction by a tilted guide rod **411** provided between a position immediately below the extrusion head **410** and a position immediately below an article removing station **A** employing the article removing device **403**. The mold **400** is adapted to clamp the parison extruded from the extrusion head **410** at a position immediately below the extrusion head **410**, to be moved to the position immediately below the article removing station A by the article removing device **403**, to perform blow molding of the parison by the operation of a blowing device (not shown), and to eject the article to discharge by the action of the ejector device (incorporated in the mold **402** in the shown embodiment). It should be noted that the portion of the parison extending upwardly from the upper surface of the mold **402** is cut by a cutter (not shown) at the stage arranged below the extrusion head **410**.

The article removing device **403** is movable between an article removing position **A**, a defective article discharging position **B** and a normal article discharging position **C** by a motor **412**. The article removing device **403** is adapted to be driven up and down by a lifting cylinder **413** and carries a pair of chucks **414** which can be driven to open and close by means of an air cylinder (not shown). The article removing device **403** provides (a) a flash configuration correcting function for clamping the upper end of the molten parison projecting from the upper surface of the mold **402** set up the article removing position **A** by the chucks **414** before solidification to shape the same into a flat and vertically extending configuration. The article removing device **403** also provides (b) an article removing function for clamping the upper flash formed through the above-mentioned (a) with the chuck **414** to remove the article from the mold **402** after blow molding within the mold **402**.

The defective discharge device **404** comprises a defective discharging chute **421** arranged below the defective article discharging position **B** and a defective article receptacle **422** for receiving the defective articles released from clamping of the chucks **414** of the article removing device **403**.

The normal article discharging device **405** includes a normal article discharging chute **423**, an orienting device **424** and a normal article discharging conveyer **425** arranged below the normal article discharging position **C** for discharging the normal articles released from clamping by the chucks **414** of the article removing device **403** to the downstream processes.

Furthermore, the blow molding machine **400** is provided with a defective discrimination control device **300** similarly to the foregoing blow molding machine **1**. The blow molding machine **400** makes quality discrimination for the normal articles and defective articles during the process from the stage of initiation of extrusion of the parison by the extruder to the stage of removing the articles by the article removing device **403**, and, at the article removing stage, controls the article removing device **403** to discharge the

normal articles to the normal article discharging device **405** and the defective articles to the defective article discharging device **404**.

Accordingly, in the blow molding machine **400** of **Figs. 25** and **26**, the operations as set out in the following paragraphs (**1**) to (**5**) are performed.

(**1**) The mold **402** is lifted up at the position immediately below the extrusion head **410** and locked for clamping the molten parison. Thereafter, the portion of the molten parison projecting upwardly from the upper surface of the mold **402** is cut.

(**2**) The mold **402** is moved down to the position immediately below the article removing position A, or during downward movement, blow molding of the parison is performed by the blowing device.

(**3**) Simultaneously with starting blow molding in the foregoing (**2**), the chucks **414** of the article removing device **403** are lowered to the article removing position **A** to clamp the cut upper end to hold the upper flash in a flat and vertically extending configuration.

(**4**) Opening the mold **402**, the chucks **414** of the article removing device **403** are moved upwardly at the article removing position **A** to remove the article.

It should be noted that the defective article discrimination control device **300** performs discrimination during the period from the stage of initiation of extrusion of parison to the stage of removal of the article by the article removing device **403**.

(**5**) The defective discrimination control device **300** controls the article removing device **403** on the basis of discrimination between the normal articles and the defective articles for discharging the normal articles to the normal article discharging device **405** and discharging the defective articles to the defective article discharging device **404**.

It should be noted that, in the shown embodiment of the invention, it is possible to employ the article removing device having the flash configuration correcting function and the article removing function even for the rotary type blow molding machine.

Also, in the shown embodiment of the invention, it is possible to provide the flash configuration correcting device and the article removing device having the flash configuration correcting function and the article removing function independently of the other.

As set forth, according to the present invention, it becomes possible to remove, with certainty the molded article and to separately discharge the normal articles and the defective articles in a continuous operation without stopping operation at any operating condition from initiation of molding operation to normal operating state.

(B) Parison Length Control Method

(First Embodiment) (**Figs. 27** to **36**)

As shown in **Figs. 35** and **36**, a rotary type blow molding apparatus **510** includes an extruder **512** for extruding a tubular molten parison **511** hanging downwardly in a vertical direction. The blow molding machine **510** is provided with six pairs of molds **516** for clamping and closing both end of the parison. The six pairs of molds **516** are mounted on a turntable **515** via mounting plates **517**, which turntable **515** is, in turn, rotatably mounted on a base **513** arranged in front of the extruder **512**, for rotation about a support shaft **514**. Each of the six pairs of the molds **516** are designed to be intermittently moved in the circumferential direction in order through stations A to F shown in **Fig. 35**, so that blow molding is sequentially performed for forming the molten parison **511** by blowing the blowing gas into the parison while closed by the molds **516** to expand the latter until the configuration thereof becomes coincident with that of the cavity of the molds **516** during one cycle of circumferential movement through the stations A to F.

The extruder **512** comprises a lower base **521**, an upper base **523** provided above the lower base **521** to be driven to rotate in a horizontal direction relative to the lower base **521** by means of a rotatingly driving mechanism **522**, and an extruder body **525** provided above the upper base **523** and adapted to be driven in a vertical direction by means of a vertical driving mechanism **524** so as to supply the molten parison **511** to the pair of molds **516** at the lowered position.

The extruder body **525** has a hopper **526** for supplying a pellet form thermoplastic resin. A screw **528** is driven to rotate by a motor **527** or so forth and is incorporated at the lower portion of the hopper **526**. The hopper **526** is also provided with a cylinder **529** which is adapted to be heated by a heating device not shown. The thermoplastic resin molten in the cylinder **529** is supplied to one pair of the molds **516** as a tubular molten parison **511** through tubular extruding die heads **530** provided at the tip end of the cylinder **529.** A parison cutting device **531** is provided below the die head **530.** A cutter **532** of the parison cutting device **531** is adapted to cut the parison so that the upper end of the parison **511** supplied in the pair of molds **516** is slightly projected from the upper surface of the pair of molds **516**.

The blow molding machine **510** is provided with a controller **540** as shown in **Fig. 27** to obtain the given length of the parison (the target parison length : it is a parison length measured by the cutter **532** in this embodiment) so that the lower end of the parison **511** supplied into the mold slightly protrudes from the lower surface of the pair of molds **516** at the locking timing of the pair of molds **516**, to perform the parison length control as illustrated in **Fig. 28**.

The blow molding machine **510** has a phototube **541** arranged below the die head **530** of the extruder **512** for enabling detection of a light blocking timing of the parison. Also, a controller **540** optionally includes an input device **542**, a monitor device **543** and a motor driver **544**.

The controller **540** operates in (A) control constant calculation mode, (B) deadband calculation mode and (C) normal operation mode which will be discussed in further detail hereinafter.

(A) Control Constant Calculation Mode (see **Figs. 27** to **31**)

This mode is performed for preliminarily deriving a relationship between the parison length of the resin to be used (the light blocking period) and the extruder screw rotation speed N, during a test molding process.

At this time, a counter **551** of the controller **540** obtains the cutting timing of the parison **511** by the parison cutting device **531** and the light blocking time by the parison **511** passing across the phototube **541** for deriving the difference of the timings as the light blocking period t and uses this light blocking period t at the time of locking the parison **511** as a value corresponding to the parison length (current parison length).

The relationship between the light blocking period t and the screw rotation speed N can be determined through the following equations (**1**) to (**6**). Namely, assuming that the resin extrusion amount (weight of the resin extruded within a unit time) is Q, the resin pressure (at the tip end of the screw) is P, the parison weight is M, and constants are A, B, C, D and E, by removing P^n from an equation (**1**) expressing the screw characteristics and an equation (**2**) expressing the die characteristics, the following equation (**3**) can be obtained.

$$Q = A \times N - B \times P^n \quad (1)$$

$$Q = C \times P^n \quad (2)$$

$$Q = D \times N \text{ (relationship between extrusion amount and the screw rotation speed)} \quad (3)$$

$$D = A \times C/(C + B)$$

The relationship between the extrusion amount and the light blocking period can be expressed by the following equation (**4**). Since what are actually measured are N and t, by removing Q from the equations (**3**) and (**4**), the following equation (**5**) can be obtained

$$Q = M/t \quad (4)$$

$$N = a \times (1/t) \quad (5)$$

From the foregoing equation (**5**), **1**/t and N are proportional. As shown in **Fig. 29**, by adjusting the screw rotation speed in a magnitude of ΔN relative to a fluctuation magnitude Δt of the light blocking period, the target parison length can be accurately obtained.

A control constant "a" of the equation (**5**) can be derived through the following equation (**6**) by obtaining the light blocking periods t_1, t_2 corresponding to two screw rotation speeds N_1, N_2. It should be noted that determination of a is normally performed once upon changing of the resin.

By replacing two points ($1/t_1$, N_1) and ($1/t_2$, N_2) to a general equation Y = aX + b of a linear function, the equation is modified to $N_1 = a \times (1/t_1) + b$, $N_2 = a \times (1/t_2) + b$. As a result, the following equation (**6**) can be obtained.

$$a = \frac{t_1 \times t_2 \times (N_1 - N_2)}{(t_2 - t_1)} \quad (6)$$

Accordingly, the controller **540** generates a property measuring demand during the test molding process, as shown in **Figs. 27** and **28** so as to receive the property measuring screw rotation speeds N_1 and N_2 through the input device **542** and drive the motor **527** of the screw **528** at one of two speeds N_1 and N_2 through a motor driver **544**. It should be noted that the motor speed of the motor **527** is detected by a pulse generator **533** and fed back to the motor driver **544**. The controller **540** connects the output of the counter **551** to a control constant calculation circuit "1" (see **Fig. 27**) to derive the light blocking period t_1 and t_2 corresponding to two speeds N_1, N_2. Furthermore, the controller **540** derives the control constant "a" applying the property indicative values N_1, N_2, t_1 and t_2 to the foregoing equation (**6**). The control constant "a" thus derived is stored in a data memory **552**.

In summary, the controller **540** sets the screw rotation speed N_1 and measures the light blocking period t_1 six times after the speed of the screw **528** reaches the speed N_1 for setting an average value as the light blocking period t_1 as shown in **Fig. 30**. Also, the controller **540** sets the screw rotation speed N_2 and measures the light blocking period t_2 six times after the speed of the screw **528** reaches the speed N_2 for setting an average value as the light blocking period t_2. The reason for measuring the light blocking period for deriving t_1 and t_2 six times (n times) is to cancel fluctuation of the measured value within the later-mentioned deadband.

(B) Deadband Calculation Mode (see **Figs. 27, 28** and **31**)

This mode is adapted to set the width of the deadband, in which the correction for the extruder screw rotation speed is not performed, by detecting fluctuation of the current parison length (light blocking period t)with a relatively short period and by setting the width corresponding to the magnitude of the detected fluctuation.

In general, the parison length may fluctuate according to elapsed time while the average value fluctuates moderately as illustrated in **Fig. 31**(A). Respective fluctuation at respective measuring timing fluctuate about the average value within a relatively

small range. Such small fluctuation is caused due to fluctuation of the cut edge configuration cut by the cutter **532** or vibration of the parison, and may not be considered as the fluctuation of the extrusion amount per se. Namely, the object for control is substantial variation of the parison length (shown by solid line). The small fluctuation (shown by broken line) is preferably ignored because of the possibility of causing hunting. Therefore, according to the present invention, the width of the small fluctuation (broken line) is measured automatically for setting the deadband. The parison length control is performed to obtain the result as illustrated in **Fig. 31**(B).

In summary, since the parison length fluctuates as shown in **Fig**. **31**(A), the overall fluctuation width W_2 can be obtained by obtaining data every hour. However, through measurement over a substantially shorter interval (approximately **1** to **5** minutes) in which the substantially large and moderate variations are not affected, only W_1 can be obtained. Therefore, by obtaining this data before obtaining the normal article, the deadband can be set for the subsequent molding operation utilizing this data.

The fluctuation of the parison length may be applied for a statistical standard deviation σ. By setting the deadband to a width of **3**σ, theoretically **99.7%** of small fluctuations can be ignored so that the control for correcting the extruder screw rotation speed is performed only when a fluctuation in excess of the deadband is caused.

Accordingly, the controller **540** generates a deadband automatic measurement demand after initiation of molding, as shown in **Figs. 27** and **28** and connects the output of the counter **551** to a deadband calculation circuit "**2**" (see **Fig. 27**) to measure the light blocking period t many times (e.g. **60** times) to derive the average σ and set the deadband based on the σ. The deadband width thus derived is stored in the data memory **52**.

(C) Normal Operation Mode (see **Figs. 27, 28, 32** to **34**)

This mode is performed during normal molding operation to detect the current parison length (light blocking period t), to derive a parison length difference (light blocking period difference T) between the current parison length(the reciprocal of the light blocking period t) and the target parison length (the reciprocal of the target light blocking period), to control the extruder screw rotation speed (N) by calculating the correction value (ΔN) of the extruder screw rotation speed corresponding to the parison length difference (light blocking period difference) while employing the preliminarily set control constant of the mode(a), and thus to obtain the target parison length. It should be noted that the target light blocking period to can be obtained through $l_0/L = t_0$/molding cycle (l_0: the parison length from the cutter **532** to the phototube **541**, L is the target parison length; see **Fig. 27**).

Accordingly, as shown in **Figs. 27** and **28**, the controller **540**, in the normal molding process, reads out the control constant "a" and the deadband width from the data memory **552**, connects the output of the counter **551** to a correction amount calculation circuit "**3**" (see **Fig. 27**), derives a difference T between the reciprocal of the light blocking period t and the reciprocal t_0 of the target light blocking period, and calculates the correction magnitude ΔN of the extruder screw rotation speed corresponding to the light blocking period difference T employing the control constant "a" when the light blocking period different T is out of the deadband. Then, the controller **540** controls driving of the motor **527** of the screw **528** through the motor driver **544** to attain the target parison length.

It should be noted that the controller **540** may employ the following control architectures of (C-1) to (C-3), in practice.

(C-1) Control Architecture of **Fig. 32**(A)

In this control architecture, control is performed by following three ranges depending upon light blocking period differnce T:

① deadband;

② proportional correction range; and

③ abnormality correction range.

In **Fig. 32**(A), PN denotes an upper limit of the correction magnitude for the extruder screw rotation speed. When the calculated correction magnitude α exceeds PN, the correction magnitude is limited to PN. In concrete, the following control is performed (see **Fig. 33**).

(**1**) After initiation of molding operation, the light blocking period t is measured for **60** times to derive the average σ. Then, the deadband is set to a width corresponding to 3σ. The process of this (**1**) can be neglected.

(**2**) By measuring the light blocking period t, $\Delta\tau = \mathbf{1}/t - \mathbf{1}/t_0$ relative to the target light blocking period t_0 is derived.

(**3**) At every extrusion chute, $\Delta\tau$ is monitored. When the $\Delta\tau$ becomes outside of the deadband, an average light blocking period difference T is taken for $\Delta\tau_1$ to $\Delta\tau_6$ of the subsequent six extrusion chutes. If $|T|$ becomes outside of the deadband, correction of the extruder screw rotation speed is initiated. Here, the reason to judge whether the correction is to be performed or not by obtaining the average T of $\Delta\tau_1$ to $\Delta\tau_6$ after $\Delta\tau_0$ is to avoid initiation of correction in response to a temporary fluctuation (measurement error) for only one chute.

(**4**) Utilizing the foregoing (**3**), an absolute value of the extruder screw rotation speed correction magnitude $\alpha = a \times |T|$ is derived.

(**5**) If α > PN, judgment within the proportional

correction range is made so that the screw rotation speed is accelerated for $\Delta N = \alpha$ when $T < 0$, the screw rotation speed is decelerated for $\Delta N = -\alpha$ when $T > 0$.

(6) If $\alpha > PN$, judgment within the abnormality correction range is made, so that the screw rotation speed is accelerated for $\Delta N = PN$ when $T < 0$, the screw rotation speed is decelerated for $\Delta N = -PN$ when $T > 0$.

(C-**2**) Control Architecture of **Fig. 32**(B)

This control architecture narrows the deadband (for instance, the width of the deadband is set at 2σ) and expand the proportional correction range for control.

Even in this control architecture, control is performed by following three ranges depending upon light blocking period difference T:

① deadband;
② proportional correction range; and
③ abnormality correction range.

The concrete operation is the same as that illustrated in **Fig. 33**.

(C-3) Control Architecture of **Fig. 32(C)**

This architecture is established by expanding the minimum correction magnitude in the proportional correction range by narrowing the deadband (C-**2**) similarly to (C-**2**).

This control architecture is effective in the following case. Namely, in case the resolution is rough in the extruder screw rotation speed control, the minimum correction magnitude cannot be made smaller. In such case, the deadband can not be narrowed beyond the possible minimum correction magnitude in case of the control architecture of **Fig. 32**(B). In contrast, in case of the control architecture of **Fig. 32**(C), the deadband can be narrowed beyond the range where the correction magnitude in the proportional correction range becomes a possible minimum value. In such case, by constant magnitude correction, greater correction than that of **Fig. 32(B)** is provided to overrun the target value. While such control architecture thus tends to cause difficulty to precisely correct the screw rotation speed at the target value, it may be possible to make adjustment not to exceed the deadband so as to permit narrowing of the deadband.

Even in this control architecture, control is performed by following three ranges depending upon light blocking period differnce T:

① deadband;
② constant magnitude correction range;
③ proportional correction range; and
④ abnormality correction range.

In **Fig. 32**(C), LB represents the range of fluctuation of the light blocking period difference T in the constant magnitude correction, LN represents an absolute value of the correction magnitude in the constant magnitude correction. Also, PN represents an upper limit of the correction magnitude for the extruder screw rotation speed. When the correction magnitude α is calculated and exceeds PN, the correction magnitude is limited to PN. In summary, the control is performed through the following processes of **(1)** to **(7)** (see **Fig. 34)**

(1) The light blocking period t is measured **60** times to derive the average σ. Then, the deadband is set to a width corresponding to 2σ and LB.

(2) By measuring the light blocking period t, $\Delta\tau = 1/t - 1/t_0$ relative to the target light blocking period t_0 is derived.

(3) At every extrusion chute, $\Delta\tau$ is monitored. When the $\Delta\tau$ is outside of the deadband, an average light blocking period difference T of $\Delta\tau_1$ to $\Delta\tau_6$ of the subsequent six extrusion chute is taken. If $|T|$ becomes outside of the deadband, correction of the extruder screw rotation speed is initiated. Here, the reason to judge whether correction is to be performed or not is made by obtaining the average T of $\Delta\tau_1$ to $\Delta\tau_6$ after $\Delta\tau_0$ to avoid initiation of correction in response to a temporary fluctuation (measurement error) for only one chute.

(4) Though the foregoing **(3)**, if $|T| > LB$, judgment within the constant magnitude correction range is made so that the absolute value α of the extruder screw rotation speed correction magnitude is set at LN to accelerate the screw rotation speed by $\Delta N = LN$ when $T < 0$, to decelerate the screw rotation speed by $\Delta N = -LN$ when $T > 0$.

(5) Through the foregoing **(3)**, if $|T| > LB$, the absolute value $\alpha = a \times |T|$ of the extruder screw rotation speed correction magnitude is derived.

(6) If not $\alpha > PN$, judgment within the proportional correction range is made, so that the screw rotation speed is accelerated for $\Delta N = \alpha$ when $T < 0$, the screw rotation speed is decelerated for $\Delta N = -\alpha$ when $T > 0$.

(7) If $\alpha > PN$, judgment within the abnormality correction range is made, so that the screw rotation speed is accelerated for $\Delta N = PN$ when $T < 0$, the screw rotation speed is decelerated for $\Delta N = -PN$ when $T > 0$.

The effects of the shown embodiment will be discussed herebelow:

(1) The control constant "a" is calculated automatically. Accordingly, the control constant "a" can be derived quickly without relying on the operator's trial and error, and thus provides high reproducing ability of the control.

(2) Since the control constant "a" can be derived corresponding to the resin, it may provide high

precision of control.

(3) Since the parison length is controlled on the basis of the error (parison length difference) between the current parison length and the target parison length, high precision can be provided for control. Also, since the control is performed depending upon the parison length difference, possibility of causing hunting can be reduced and the converging period can be shortened.

(4) Since the object of control is the extruder screw rotation speed and not to modify the timing of locking of the molds, synchronization to the parison thickness control which is performed cyclically with a constant interval can be facilitated. In addition, since the parison length can be controlled to be constant, the thickness distribution of the article can be controlled with high precision.

(5) Since the locking timing of the molds is not modified, it is unnecessary to adjust the operation timing and the operation speed of the mechanical system to permit adaptation for high speed molding.

(6) The deadband can be set on the basis of the data reflecting the fluctuation of the current parison length with respect to the molding device to be actually used. Therefore, the deadband can be set at a proper range to successfully avoid hunting.

(7) The deadband can be calculated automatically. Accordingly, the deadband can be set quickly without requiring trial and error of the operator. Also, high reproducing ability can be achieved.

(8) Since the current parison length is calculated from the light blocking period, it becomes possible to accurately and easily derive the parison length.

(9) The items which the operator enters through the input device **542** are only the target parison length and the mounting position of the phototube **541**. Therefore, the control precision is not affected by the particular ability of the operators.

(10) Since the controller **540** monitors the parison length difference, an alarm function for sensing abnormal parison length can be provided by setting an allowable range of the parison length.

(11) Even when the screw rotation speed can be set in an arbitrary manner, the parison length can be automatically controlled at the target length. Namely, even when arbitrarily set the screw rotation speed may quickly converge to the desired speed. Therefore, setting of the screw rotation speed is significantly facilitated.

(12) It has been commonly performed in practical operation that during the period from initiation of the molding operation to stabilizing of the parison, one can effect concentration of the parison, stacking of the parison on the guide pin of the molds or so forth by driving the screw at lower speed than the normal speed, and accelerating the screw rotation speed to the normal speed after stabilization of the parison. However, by employing the present invention the molding operation is initiated by setting the screw rotation speed at a low speed, and the foregoing problem can be successfully avoided to permit smooth take-up of the molding operation.

It should be noted that, in the shown embodiment of the invention, the current parison length measurement may not be specified to the light blocking period measurement by the phototube, but can be done by various other means, such as an image processing camera, or the like.

As set forth above, according to the present invention, the control constant can be determined with respect to the resin to be used. Also, with the present invention, the parison length can be controlled with high precision so as to permit high precision control of the thickness distribution of the article. In addition, the present invention can be well adapted to high speed molding.

(Second Embodiment) (**Figs. 37** to **46**)

As shown in **Figs.45** and **46**, a rotary type blow molding apparatus **610** includes an extruder **612** for extruding a tubular molten parison **611** hanging downwardly in a vertical direction. The blow molding machine **610** is provided with six pairs of molds **616** for clamping and closing both end of the parison. The six pairs of molds **516** are mounted on a turntable **615** via mounting plates **617**, which turntable **615** is, in turn, rotatably mounted on a base **613** arranged in front of the extruder **612**, for rotation about a support shaft **614**. Each of the six pairs of the molds **616** are designed to be intermittently moved in the circumferential direction in order through stations A to F shown in **Fig. 45**, so that blow molding is sequentially performed for forming the molten parison **611** by blowing the blowing gas into the parison while closed by the molds **616** to expand the latter until the configuration thereof becomes coincident with that of the cavity of the molds **616** during one cycle of circumferential movement through the stations A to F.

The extruder **612** comprises a lower base **621**, an upper base **623** provided above the lower base **621** to be driven to rotate in a horizontal direction relative to the lower base **621** by means of a rotatingly driving mechanism **622**, and an extruder body **625** provided above the upper base **623** and adapted to be driven in a vertical direction by means of a vertical driving mechanism **624** so as to supply the molten parison **611** to the pair of molds **616** at the lowered position.

The extruder body **625** has a hopper **626** for supplying a pellet form thermoplastic resin. A screw **628** is driven to rotate by a motor **627** or so forth and is

incorporated at the lower portion of the hopper **626**. The hopper **626** is also provided with a cylinder **629** which is adapted to be heated by a heating device not shown. The thermoplastic resin molten in the cylinder **629** is supplied to one pair of the molds **616** as a tubular molten parison **611** through tubular extruding die heads **630** provided at the tip end of the cylinder **629**. A parison cutting device **631** is provided below the die head **630**. A cutter **632** of the parison cutting device **631** is adapted to cut the parison so that the upper end of the parison **611** supplied in the pair of molds **616** is slightly projected from the upper surface of the pair of molds **616**.

The blow molding machine **610** is provided with a controller **640** as shown in **Fig. 37** to obtain the given length of the parison (the target parison length : it is a parison length measured by the cutter **632** in this embodiment) so that the lower end of the parison **611** supplied into the mold slightly protrudes from the lower surface of the pair of molds **616** at the locking timing of the pair of molds **616**, to perform the parison length control as illustrated in **Fig. 38**.

The blow molding machine **610** has a phototube **641** arranged below the die head **630** of the extruder **612** for enabling detection of a light blocking timing of the parison. Also, a controller **640** optionally includes an input device **642**, a monitor device **643** and a motor driver **644**.

The controller **640** operates in (A) deadband calculation mode, (B) control constant calculation mode, and (C) correction calculation mode as will be discussed hereinafter.

(A) Deadband Calculation Mode (see **Figs. 37, 38, 41**)

This mode is performed at the initial stage of the normal molding process for detecting fluctuation of the current parison length (light blocking period t) over a relatively short period and setting the deadband, in which the correction of the extruder screw rotation speed N is based on the magnitude of the fluctuation.

In general, the parison length may fluctuate according to elapsed time while the average value fluctuates moderately as illustrated in **Fig. 41**(A). Respective fluctuation at respective measuring timing fluctuates about the average value within a relatively small range. Such small fluctuation is caused due to fluctuation of the cut edge configuration cut by the cutter **632** or vibration of the parison, and may not be considered as the fluctuation of the extrusion amount per se. Namely, the object for control is substantial variation of the parison length(shown by solid line). The small fluctuation (shown by broken line) is preferably ignored because of the possibility of causing hunting. Therefore, according to the present invention, the width of the small fluctuation (broken line) is measured automatically for setting the deadband. The parison length control is performed to obtain the result as illustrated in **Fig. 41**(B).

In summary, since the parison length fluctuates as shown in **Fig. 41**(A), the overall fluctuation is over width $\mathbf{W_2}$. In practice, as shown in **Fig. 41**(A), by obtaining data per every hour, $\mathbf{W_2}$ can be determined. However, through measurement within a substantially shorter interval (approximately **1** to **5** minutes) in which the substantially large and moderate variations are not effective, only W_1 can be obtained. Therefore, by obtaining this data before obtaining the normal article, the deadband can be set for the subsequent molding operation utilizing this data.

The fluctuation of the parison length may be applied for a statistical standard deviation σ. By setting the deadband in the width of $\mathbf{3\sigma}$, theoretically **99.7%** of small fluctuations can be ignored so that the control for correcting the extruder screw rotation speed is performed only when a fluctuation in excess of the deadband is caused.

Accordingly, the controller **640** generates a deadband automatic measurement demand after initiation of normal molding, as shown in **Figs. 37** and **38** and connects the output of the counter **651** to a deadband calculation circuit **"2"**(see **Fig. 37**) to measure the light blocking period t for many times (e.g. **60** times) to derive the average σ and set the deadband based on the σ. The deadband width thus derived is stored in the data memory **652**.

(B) Control Constant Calculation Mode (see **Figs. 37** to **40**)

This mode is adapted to derive a relationship between the parison length of the resin currently used (light blocking period t) and the extruder screw rotation speed N during normal molding operation.

At this time, a counter **651** of the controller **640** obtains the cutting timing of the parison **611** by the parison cutting device **631** and the light blocking timing by the parison **611** passing across the phototube **641** for deriving the difference of the timings as the light blocking period t, and uses this light blocking period t at the time of locking the parison **611** as a value corresponding to the parison length (current parison length).

The relationship between the light blocking period t and the screw rotation speed N can be determined through the following equations **(1)** to **(6)**. Namely, assuming that the resin extrusion amount (weight of the resin extruded within a unit time) is Q, the resin pressure (at the tip end of the screw) is P, the parison weight is M, and constants are A, B, C, D and E, by removing P^n from the equation **(1)** expressing the screw characteristics and the equation **(2)** expressing the die characteristics, the following equation **(3)** can be obtained.

$$Q = A \times N - B \times P^n \quad (1)$$
$$Q = C \times P^n \quad (2)$$
$$Q = D \times N \text{ (relationship between extrusion amount and the screw rotation speed)} \quad (3)$$

The relationship between the extrusion amount and the light blocking period can be expressed by the following equation (**4**). Since what are actually measured are N and t, by removing Q from the equations (**3**) and (**4**), the following equation (**5**) can be obtained

$$Q = M/t \quad (4)$$
$$N = a \times (1/t) \quad (5)$$

From the foregoing equation (**5**), **1**/t and N are proportional. As shown in **Fig. 29**, by adjusting the screw rotation speed in a magnitude of ΔN relative to a fluctuation magnitude Δt of the light blocking period, the target parison length can be accurately obtained.

The control constant "a" of the equation (**5**) can be determined through the following equation **(6)** based on the current screw rotation speed N_i and the current light blocking period t_i corresponding thereto.

$$a = t_i N_i \quad (6)$$

Accordingly, as shown in **Fig. 37**, the controller **640**, during normal molding process, obtains the screw rotation speed N_i and the light blocking period t_i to derive the light blocking period difference T which will be discussed later, to connect the output of the counter **651** to the control constant calculation circuit **"1"** as long as the light blocking period difference T is output the deadband stored in the data memory **652** for deriving the control constant "a" employing the foregoing equation **(6)** with respect to mutually corresponding N_i and t_i. The control constant "a" thus derived is stored in the data memory **652**. At this time, the revolution speed of the motor **627** driving the screw **628** is detected by the pulse generator **633** and fed back to the motor driver **644**. The controller **640** uses the detected value of the pulse generator **633** as the screw rotation speed N_1.

It should be noted that the controller **640** in practice calculates $a = T_{AVE} \cdot N_{AVE}$ by measuring the light blocking period t_i(i = **1** to **6**) to set the average thereof as t_{AVE} by sequentially performing the measurement six times when the light blocking period difference becomes out of the deadband(or normally over six times)and to set the average of the screw rotation speed at the corresponding period as N_{AVE}. The reason for six times (n times) measurement and using the average value is to ignore the fluctuations of the measured value.

In calculation of the control constant "a", it is sufficient to have one set of the screw rotation speed N(or N_{AVE}) and the light blocking period t (or t_{AVE}). Namely, although the control constant "a" can be obtained as a gradient [$N = a \times (1/t)$] of a linear function passing two points, i.e. ($1/t_1$, N_1) and ($1/t_2$, N_2), as shown in **Fig. 40**(A), it is also possible to derive the control constant can be obtained as a gradient [$N = a \times (1/t)$] of the linear function extending through origin (**0**, **0**)and one point (**1**/t, N) as shown in **Fig. 40**(B). It should be noted that when the control constant "a" is derived from the gradient of the linear function passing two points as shown in **Fig. 40**(A), the error of the control constant"a"becomes large when the two points are set in too close positions.

(C) Correction Magnitude Calculation Mode (see **Figs. 37, 38, 42** to **44**)

This mode is performed during the normal molding operation to detect the current parison length (light blocking period t), to derive a parison length difference (light blocking period difference T) between the current parison length(the reciprocal of the light blocking period t) and the target parison length (the reciprocal of the target light blocking period), to control the extruder screw rotation speed (N) by calculating the correction value (ΔN) of the extruder screw rotation speed corresponding to the parison length difference (light blocking period difference) with employing the preliminarily set control constant of the mode (a), and thus to obtain the target parison length. It should be noted that the target light blocking period to can be obtained through $l_0/L = t_0$/molding cycle (l_0: the parison length from the cutter **632** to the phototube **641**, L is the target parison length; see **Fig. 37**).

Accordingly, as shown in **Fig. 37**, the controller **640**, in the normal molding process, reads out the control constant "a" and the deadband width from the data memory **652**, connects the output of the counter **651** to a correction amount calculation circuit **"3"** (see **Fig. 37**), derives the difference T between the reciprocal of the light blocking period t and the reciprocal of the target light blocking period t_0, and calculates the correction magnitude ΔN of the extruder screw rotation speed corresponding to the light blocking period difference T employing the control constant "a" when the light blocking period difference T is outside of the deadband. Then, the controller **640** controls the driving of the motor **627** of the screw **628** through the motor driver **644** to attain the target parison length.

It should be noted that the controller **640** may employ the following control architectures of (C-**1**) to (C-**3**), in practice.

(C-**1**) Control Architecture of **Fig. 42**(A)

In this control architecture, control is performed through following three ranges depending upon light blocking period differnce T:

① deadband;
② proportional correction range; and
③ abnormality correction range.

In **Fig. 42**(A), PN denotes the upper limit of the correction magnitude for the extruder screw rotation speed. When the calculated correction magnitude α exceeds PN, the correction magnitude is limited to

PN. Specifically, the following control is performed (see **Fig. 43**).

(**1**) After initiation of the molding process, the output of the counter **651** is connected to the deadband calculation circuit "**2**". The light blocking period t is measured **60** times to derives the average σ. Then, the deadband is set to a width corresponding to 3σ. The process of this (**1**) can be neglected.

(**2**) Then, by connecting the output of the counter **651** to the correction amount calculation circuit "**3**" and by measuring the light blocking period t, the expression $\Delta\tau = 1/t - 1/t_0$ relative to the target light blocking period t_0 is derived.

(**3**) At every extrusion chute, $\Delta\tau$ is monitored. When the $\Delta\tau$ becomes outside of the deadband, the average light blocking period difference T is based upon $\Delta\tau_1$ to $\Delta\tau_6$ of the subsequent six extrusion chutes. If $|T|$ becomes outside of the deadband, correction of the extruder screw rotation speed is initiated. Here, the reason to judge whether correction is to be performed or not by obtaining the average T of $\Delta\tau_1$ to $\Delta\tau_6$ after $\Delta\tau_0$ is to avoid initiation of correction in response to a temporary fluctuation (measurement error) for only one chute.

At this time, the output of the counter **651** is connected to the control constant calculation circuit "**1**", to drive the average t_{AVE} of the light blocking period t_1 to t_6 corresponding to $\Delta\tau_1$ to $\Delta\tau_6$, derives the average N_{AVE}, of the screw rotation speeds N_1 to N_6 corresponding thereto, and to derive the control constant"a"through the equation of $\mathbf{a} = t_{AVE} \cdot N_{AVE}$.

(**4**) Next, the output of the counter **651** is again connected to the correction magnitude calculation circuit "**3**" so that the absolute value $\alpha = a \times |T|$ of the extruder screw rotation speed employing the control constant "a" derived through the process of (**3**).

(**5**) If α > PN, judgment within the proportional correction range is made so that the screw rotation speed is accelerated for $\Delta N = \alpha$ when $T < \mathbf{0}$, and the screw rotation speed is decelerated for $\Delta N = -\alpha$ when $T > \mathbf{0}$.

(**6**) If α > PN, judgment within the abnormality correction range is made, so that the screw rotation speed is accelerated for ΔN = PN when $T < \mathbf{0}$, the screw rotation speed is decelerated for ΔN = -PN when $T > \mathbf{0}$.

(C-**2**) Control Architecture of **Fig. 42**(B)

This control architecture narrows the deadband (for instance, the width of the deadband is set at $\mathbf{2}\sigma$) and expand the proportional correction range for control.

Even in this control architecture, control is performed through following three ranges depending upon the light blocking period difference T:

① deadband;

② proportional correction range; and

③ abnormality correction range.

The concrete operation is the same as that illustrated in **Fig. 43.**

(C-**3**) Control Architecture of **Fig. 42**(C)

This architecture is established by expanding the minimum correction magnitude in the proportional correction range by narrowing the deadband (C-**2**) similarly to (C-**2**).

This control architecture is effective in the following case. When resolution is rough in the extruder screw rotation speed control, the minimum correction magnitude cannot be made smaller. In such case, the deadband cannot be narrowed beyond the possible minimum correction magnitude in case of the control architecture of **Fig. 42**(B). In contrast, in case of the control architecture of **Fig. 42**(C), the deadband can be narrowed beyond the range where the correction magnitude in the proportional correction range becomes a possible minimum value. In such case, by constant magnitude correction, greater correction than that of **Fig. 42**(B) is provided to overrun the target value. While such control architecture thus tends to cause difficulty to precisely correct the screw rotation speed at the target value, it may be possible to make adjustment not to exceed the deadband so as to permit narrowing of the deadband.

Even in this control architecture, control is performed through following three ranges depending upon light blocking period differnce T:

① deadband;

② constant magnitude correction range;

③ proportional correction range; and

④ abnormality correction range.

In **Fig. 42**(C), LB represents a range of fluctuation of the light blocking period difference T in the constant magnitude correction, and LN represents an absolute value of the correction magnitude in the constant magnitude correction. Also, PN represents an upper limit of the correction magnitude for the extruder screw rotation speed. When the correction magnitude α is calculated and exceeds PN, the correction magnitude is limited to PN. Specifically the control is performed through the following processes of (**1**) to (**7**) (see **Fig. 44**)

(**1**) After initiation of the molding operation, the output of the counter **651** is connected to the deadband calculation circuit "**2**". The light blocking period t is measured **60** times to derive the average σ. Then, the deadband is set in a width corresponding to $\mathbf{2}\sigma$ and LB.

(**2**) Next, by connecting the output of the counter **651** to the correction magnitude calculation cir-

cuit "**3**" and by measuring the light blocking period t, $\Delta\tau = \mathbf{1}/t - \mathbf{1}/t_0$ relative to the target light blocking period to is derived.

(**3**) At every extrusion chute, $\Delta\tau$ is monitored. When the $\Delta\tau$ becomes outside of the deadband, an average light blocking period difference T is based upon $\Delta\tau_1$ to $\Delta\tau_6$ of the subsequent six extrusion chutes. If $|T|$ becomes outside of the deadband, correction of the extruder screw rotation speed is initiated. Here, the reason to judge whether correction is to be performed or not by obtaining the average T of $\Delta\tau_1$ to $\Delta\tau_6$ after $\Delta\tau_0$ is to avoid initiation of correction in response to a temporary fluctuation (measurement error) for only one chute.

(**4**) Though the foregoing (**3**), if $|T| > LB$, judgment within the constant magnitude correction range is made so that the absolute value α of the extruder screw rotation speed correction magnitude is set at LN to accelerate the screw rotation speed by $\Delta N = LN$ when $T < \mathbf{0}$, to decelerate the screw rotation speed by $\Delta N = -LN$ when $T > \mathbf{0}$.

(**5**) Though the foregoing (3), if ;T; > LB, the output of the counter **651** is connected to the control constant calculation circuit "**1**". An average light blocking period difference t_{AVE} of t_1 to t_6 corresponding to $\Delta\tau_1$ to $\Delta\tau_6$ is derived, an average value N_{AVE} of the screw rotation speeds N_1 to N_6 corresponding thereto is calculated and the control constant "a" is caluculated as $\mathbf{a} = t_{AVE} \cdot N_{AVE}$. Then, the output of the counter **651** is connected again to the correction magnitude calculation circuit "**3**" to derive the absolute value $\alpha = a \times |T|$ of the extruder correction magnitude is calculated.

(**6**) If α is not greater than PN, judgment within the proportional correction range is made, so that the screw rotation speed is accelerated for $\Delta N = \alpha$ when $T < \mathbf{0}$, the screw rotation speed is decelerated for $\Delta N = -\alpha$ when $T > \mathbf{0}$.

(**7**) If $\alpha > PN$, judgment within the abnormality correction range is made, so that the screw rotation speed is accelerated for $\Delta N = PN$ when $T <_{\mathbf{0}}$, the screw rotation speed is decelerated for $\Delta N = -PN$ when $T > \mathbf{0}$.

The effects of the shown embodiment will be discussed herebelow:

(**1**) The control constant "a" is calculated automatically. Accordingly, the control constant "a" can be derived quickly without relying on the operator's trial and error, and can thus provide high reproducing ability of the control.

(**2**) The control constant can be derived with respect to the current used resin, and especially depending upon the property variation of the resin in real time. Accordingly, high precision control can be achieved.

In addition, (a) since it becomes unnecessary to preliminarily perform test process for obtaining the control constant and the control constant can be derived during the normal molding process, it becomes possible to save the resin and power required for test process. (b) Even when the die head comprising the die and core is modified for new resin and for new parison configuration, normal molding operation for obtaining normal products can be directly initiated without performing the test process. (c) When the control constant derived through the test process is employed, it is possible that the control constant becomes outside of an optimal value due to variation of the property of the resin resulting from variation of the resin between lots or variation of the mixture ratio of a recycled resin to lower the precision of control. The present invention is adapted to derive the control constant from time to time so that the control constant can always be maintained at the optimal value to permit optimal control.

(**3**) Since the parison length is controlled on the basis of the error (parison length difference) between the current parison length and the target parison length, high precision can be provided for control. Also, since the control is performed depending upon the parison length difference, possibility of causing hunting can be reduced and the converging period can be shortened.

(**4**) Since the object of control is the extruder screw rotation speed and not the timing of locking of the molds, synchronization to the parison thickness control which is performed cyclically with a constant interval can be facilitated. In addition, since the parison length can be controlled to be constant, the thickness distribution of the article can be controlled with high precision.

(**5**) Since the locking timing of the molds is not modified, it is unnecessary to adjust the operation timing and the operation speed of the mechanical system to permit adaption for high speed molding.

(**6**) The deadband can be set on the basis of the data reflecting the fluctuation of the current parison length with respect to the molding device to be actually used. Therefore, the deadband can be set at the proper range to successfully avoid hunting.

(**7**) The deadband can be calculated automatically. Accordingly, the deadband can be set quickly without requiring trial and error of the operator. Also, high reproducing ability can be achieved.

(**8**) The current parison length is calculated from the light blocking period; it becomes possible to accurately and easily derive the parison length.

(**9**) The items which the operator enters through the input device **642** are only the target parison length and the mounting position of the phototube **641**. Therefore, the control precision may

not be affected by the particular ability of the operators.

(10) Since the controller **640** monitors the parison length difference, an alarm function for occurrence of abnormal parison length can be provided by setting an allowable range of the parison length.

(11) Even when the screw rotation speed can be set in an arbitrary manner, the parison length can be automatically controlled at the target length. Namely, even when the screw rotation speed is arbitrarily set, the screw rotation speed may quickly converge to the desired speed. Therefore, setting of the screw rotation speed is significantly facilitated.

(12) It has been commonly performed in practical operation that during the period from initiation of the molding operation to stabilizing of the parison, it is possible to achieve concentration of the parison, stacking of the parison on the guide pin of the molds or so forth by driving the screw at a lower speed than the normal speed, and to accelerate to screw rotation speed to the normal speed after stabilization of the parison. However, by employing the present invention the molding operation is initiated by setting the screw rotation speed at low speed, and the foregoing problems can be successfully avoided to permit smooth take-up of the molding operation.

It should be noted that, in the shown embodiment of the invention, the current parison length measurement may not be specified to the light blocking period measurement by the phototube, but can be done by various other means, such as an image processing camera or so forth.

It should be noted that, in the shown embodiment of the invention, it is used as a blow molding machine in which the both ends of the parison are clamped by molds, to which a blowing gas is blown thereto. However, the invention can be applied a blow molding machine of the blow pin type in which one end of the parison is clamped by a mold, and in which a blow gas may be blown into the closed parison. In this case, another end of the parison is clamped and blowing is performed by the blowing gas injection means which is formed separately from the mold.

As set forth above, according to the present invention, the control constant can be determined with respect to the resin to be used. Also, with the present invention, the parison length can be controlled with high precision so as to permit high precision control of the thickness distribution of the article. In addition, the present invention can be well adapted to the high speed molding.

Although the invention has been illustrated and described with respect to several exemplary embodiments thereof, it should be understood by those skilled in the art that the foregoing and various other changes, omissions and additions may be made therein and thereto, without departing from the spirit and scope of the present invention. Therefore, the present invention should not be understood as limited to any specific embodiment set out above but to include all possible embodiments which can be embodied within the scope encompassed, and equivalents thereof, as set out in the appended claims.

Claims

1. An article removing process for a blow molding machine, in which molds for clamping a parison is arranged below an extruder extruding the parison, the parison is cut above the upper surface of the mold so as to leave an upper flash on a molded article, comprising the steps of:

   correcting the configuration of the upper end of the parison into a substantially flat configuration and substantially vertically extending said configuration before solidification;

   performing quality discrimination for discriminating a normal article from a defective article during the period between initiation of extrusion of the parison and removing the article; and

   chucking the upper flash and removing the removed article to a normal article discharging destination for a normal article and to a defective discharging destination for a defective article on the basis of said quality discrimination.

2. An article removing process for a blow molding machine as set forth in claim **1**, wherein the defective discrimination step is selected from the group consisting of

   (a) judgment whether said parison is defective upon initiation of molding operation;

   (b) judgment whether said parison is defective when the length thereof is outside of a target length range;

   (c) judgment whether there is blowing gas supply failure during parison blowing;

   (d) judgment whether there is failure of a downstream facility following the blow molding machine;

   (e) judgment whether there is failure for absence of an article at an article removing station;

   (f) judgment whether a lower flash of said article is present at a predetermined position at said article removing station;

   (g) judgment whether there is abnormality when said article removing device abnormally holds the body of article; and

   (h) judgment whether a defective article is molded by molds on which absence of an article is detected in step (e) above.

3. An article removing system for a blow molding machine, in which a mold for clamping a parison is arranged below an extruder extruding the parison, the parison is cut above the upper surface of the mold so as to leave an upper flash on a molded article, comprising:

a flash configuration correcting device provided above the mold and shaping the upper end of the parison into a substantially flat and substantially vertically extending configuration before solidification of the parison;

an article removing device clamping an upper flash of the molded article and removing the article from the mold; and

a defective discrimination control device for performing quality discrimination for discriminating a normal article from a defective article between initiation of extrusion of the parison and removing the article,

and controlling said article removing device to discharge said removed article to a normal article discharging destination for a normal article and to a defective article discharging destination for a defective article, on the basis of the result of said quality discrimination.

4. An article removing system for a blow molding machine, in which a mold for clamping a parison is arranged below an extruder extruding the parison, and the parison is cut above the upper surface of the mold so as to leave an upper flash on a molded article, comprising:

an article removing device provided above the mold and shaping the upper end of the parison into a substantially flat and substantially vertically extending configuration before solidification of the parison, and clamping an upper flash of the molded article and removing the article from the mold; and

a defective discrimination control device for performing quality discrimination for discriminating a normal article from a defective article during a process between initiation of extrusion of the parison and removing the article,

and controlling said article removing device to discharge the removed article to a normal article discharging destination for a normal article and to a defective article discharging destination for a defective article, on the basis of the result of said discrimination.

5. A parison length control method for a blow molding machine, in which a parison is extruded from a extruder to hang in a substantially vertical manner, wherein the end of said parison is closed and a blowing gas is blown into the closed parison, the method comprising the steps of:

preliminarily deriving a relationship between a parison length of a resin to be used and a screw rotation speed of the extruder depending upon the resin to be used, during a test molding process;

detecting a current parison length during normal molding operation;

deriving a parison length difference between the current parison length and a target parison length;

controlling the extruder screw rotation speed by calculating a correction amount for the extruder screw rotation speed according to the preliminarily determined relationship between the parison length and the extruder screw rotation speed to attain the target parison length.

6. A parison length control method for a blow molding machine as set forth in claim **5**, which further comprises the step of deriving a fluctuation of the current parison length over a relatively short period and setting a width of a deadband, in which the correction of the extruder screw rotation speed is not performed, on the basis of the magnitude of the fluctuation.

7. A parison length control method for a blow molding machine as set forth in either of claim **5** or **6**, wherein a period, in which a light is blocked by the parison, is measured by a phototube provided below the extruder and the measured period is used as a value corresponding to the current parison length.

8. A parison length control method for a blow molding machine, in which a parison is extruded from a extruder to hang, the end of said parison is closed and a blowing gas is blown into the closed parison, the method comprising the steps of:

detecting a current parison length during normal molding operation;

deriving a parison length difference between the current parison length and a target parison length;

deriving a relationship between a parison length of a resin to be used and a screw rotation speed of the extruder;

controlling the extruder screw rotation speed by calculating a correction amount for the extruder screw rotation speed according to the determined relationship to attain the target parison length.

9. A parison length control method for a blow molding machine as set forth in claim **8**, which further comprises the step of deriving a fluctuation of the current parison length over a relatively short period and setting a width of a deadband, in which the correction of the extruder screw rotation

speed is not performed, on the basis of the magnitude of the fluctuation.

10. A parison length control method for a blow molding machine as set forth in claim **8** or **9**, wherein a period in which a light is blocked by the parison, is measured by a phototube provided below the extruder and the measured period is used as a value corresponding to the current parison length.

FIG.1

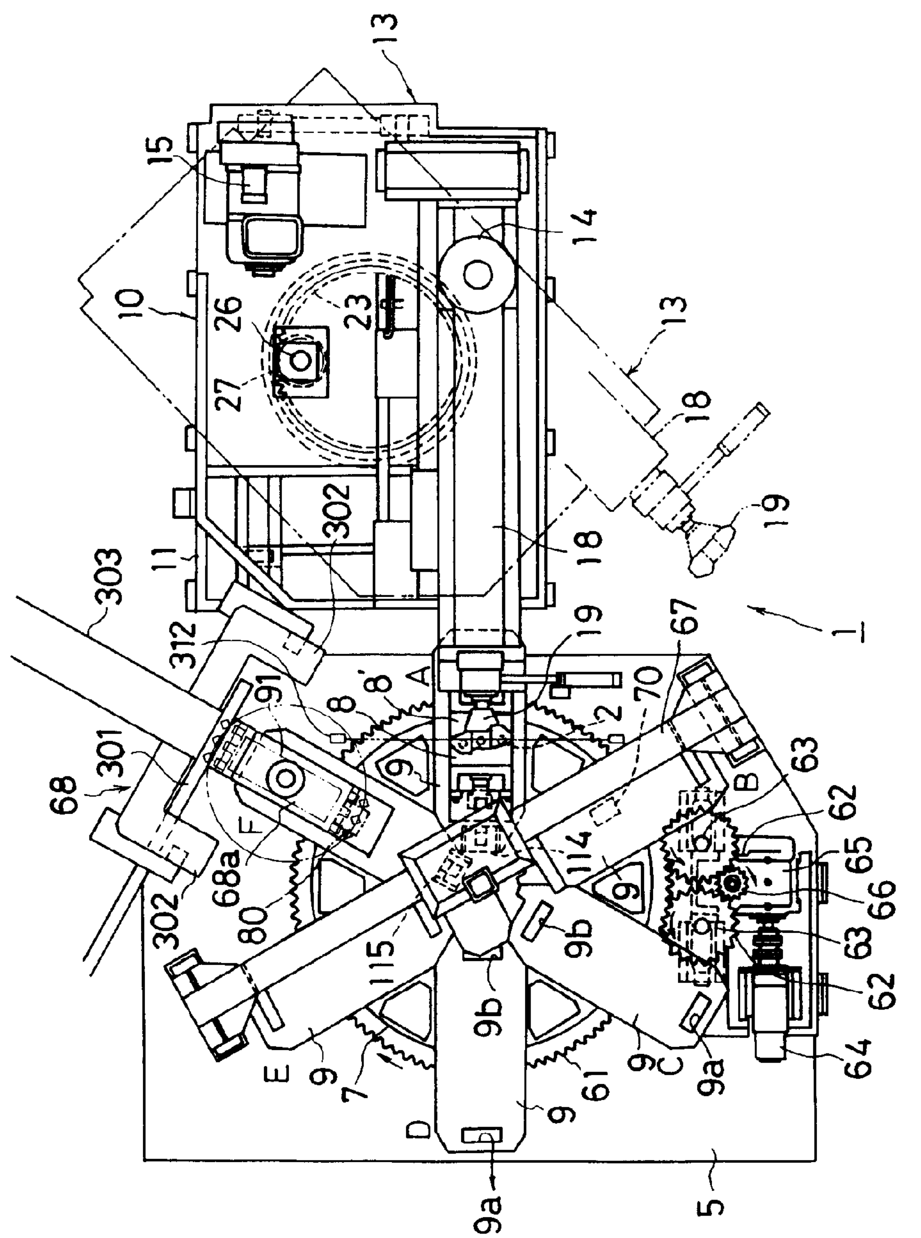

1
2
5
7
8
8'
9
9a
9b
10
11
13
14
15
18
19
23
26
27
61
62
63
64
65
66
67
68
68a
70
80
91
114
115
301
302
303
312
A
B
C
D
E
F

FIG.2

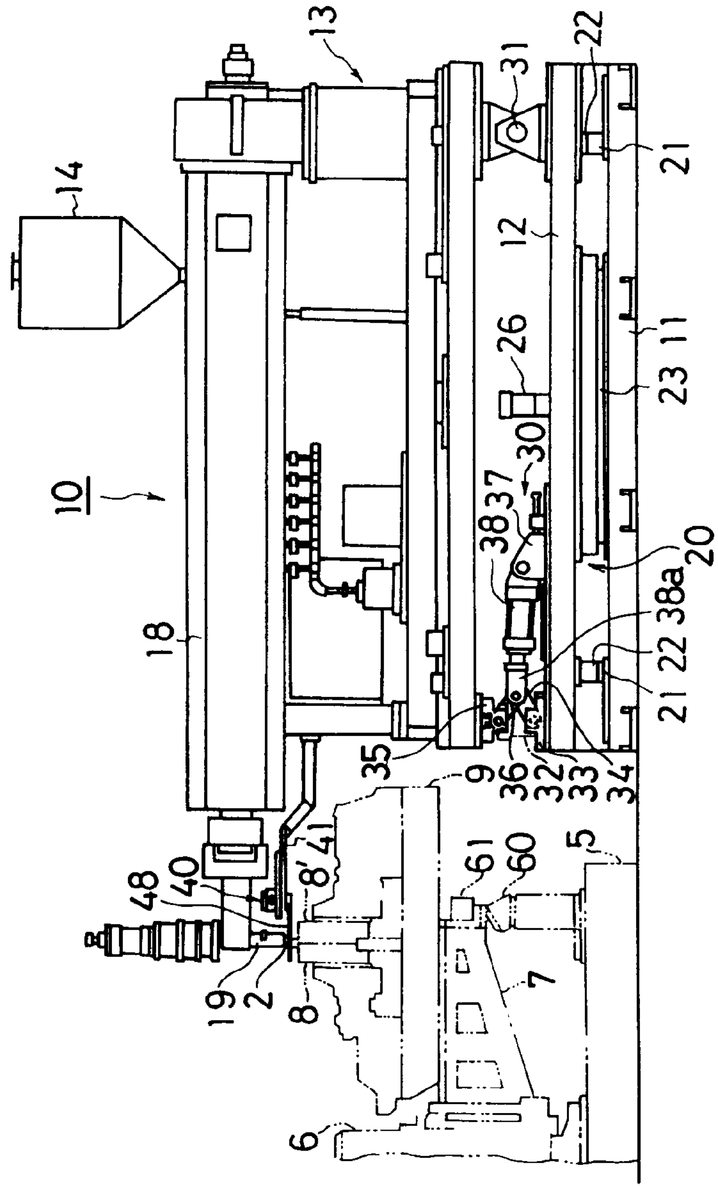

10
13
14
18
31
22
21
12
26
11
23
30
37
38
20
38a
22
21
35
36
32
33
34
9
41
8'
40
48
19
2
8
61
60
5
7
6

FIG.3

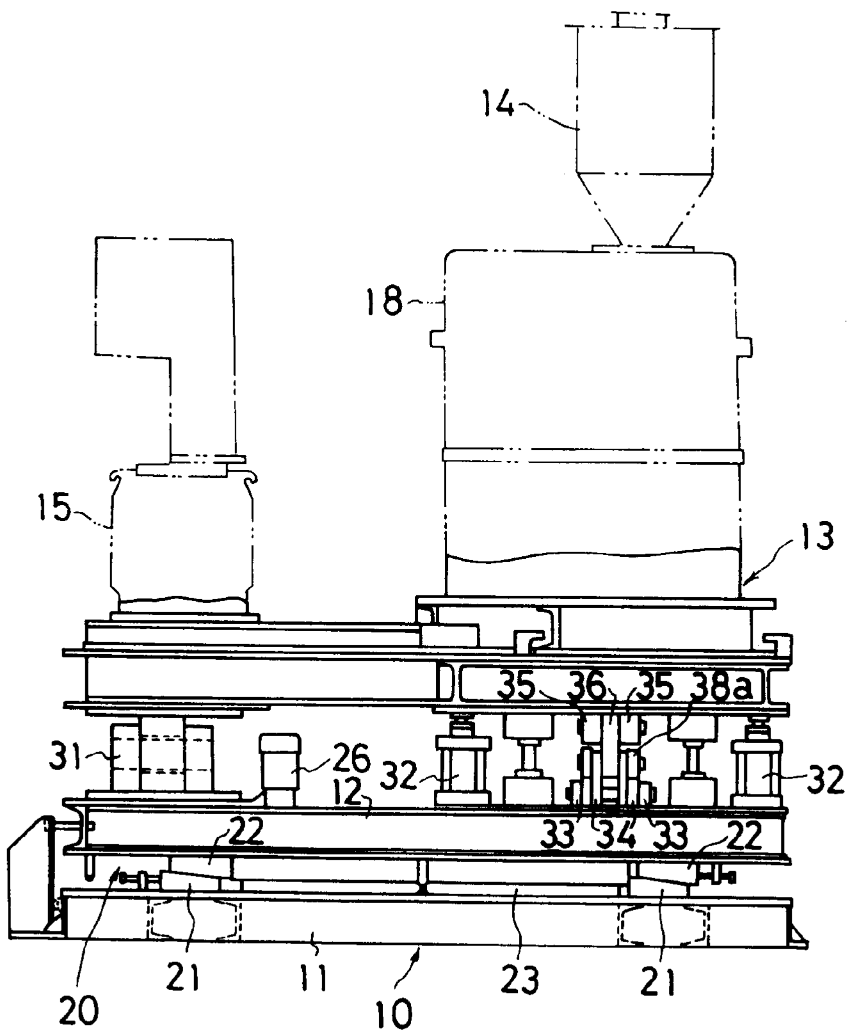
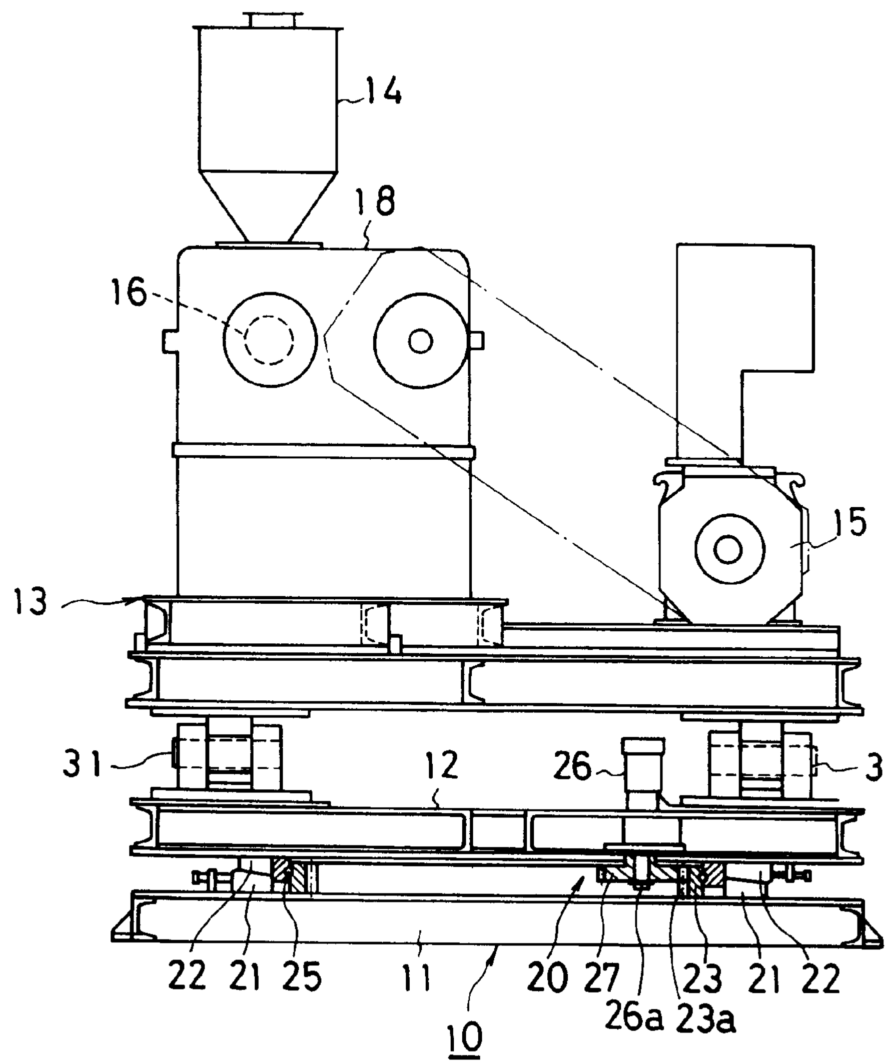


FIG.4



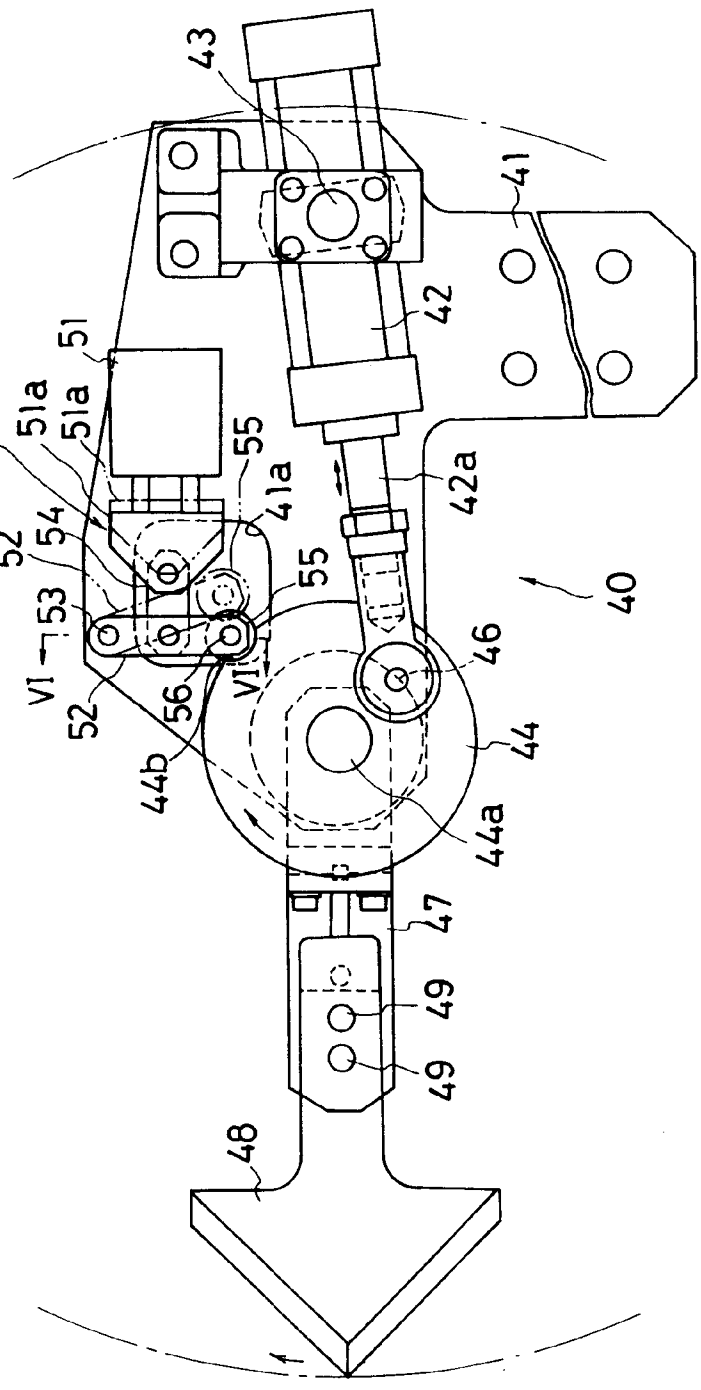

43
41
42
42a
40
46
44
44a
47
49
49
48
51
51a
51a
50
55
41a
54
52
55
53
VI
52
56
VI
44b

FIG.5

FIG.6

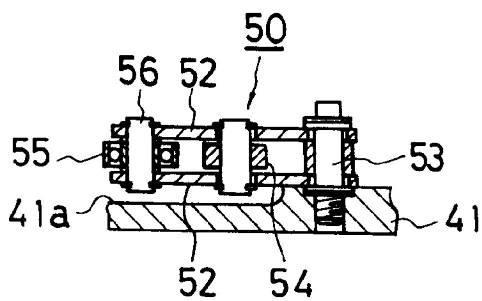


FIG. 7

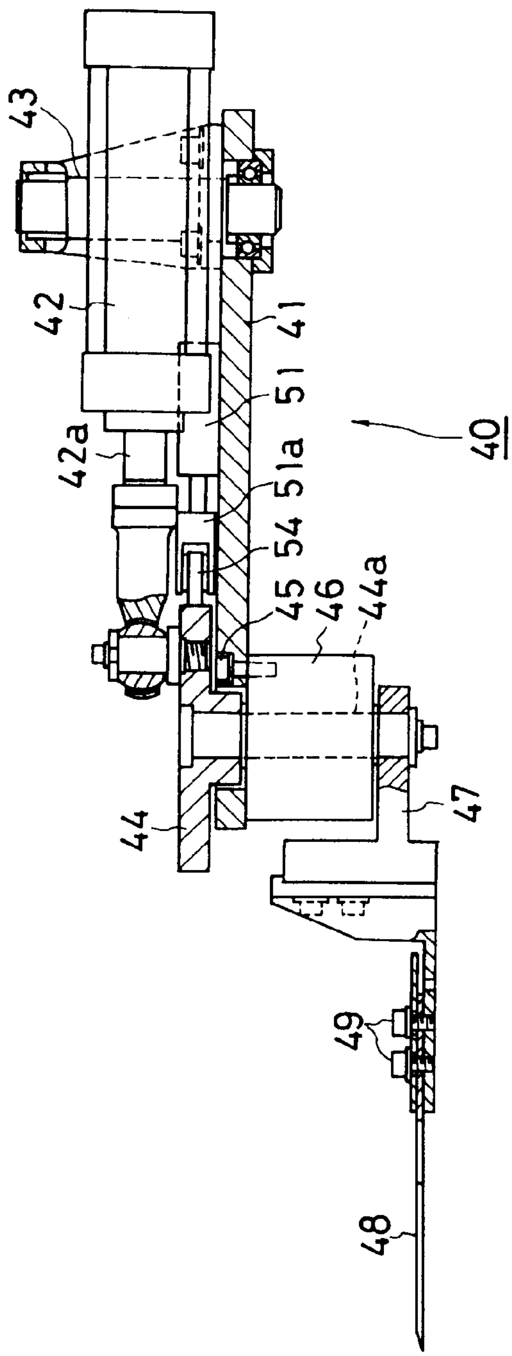


FIG.8

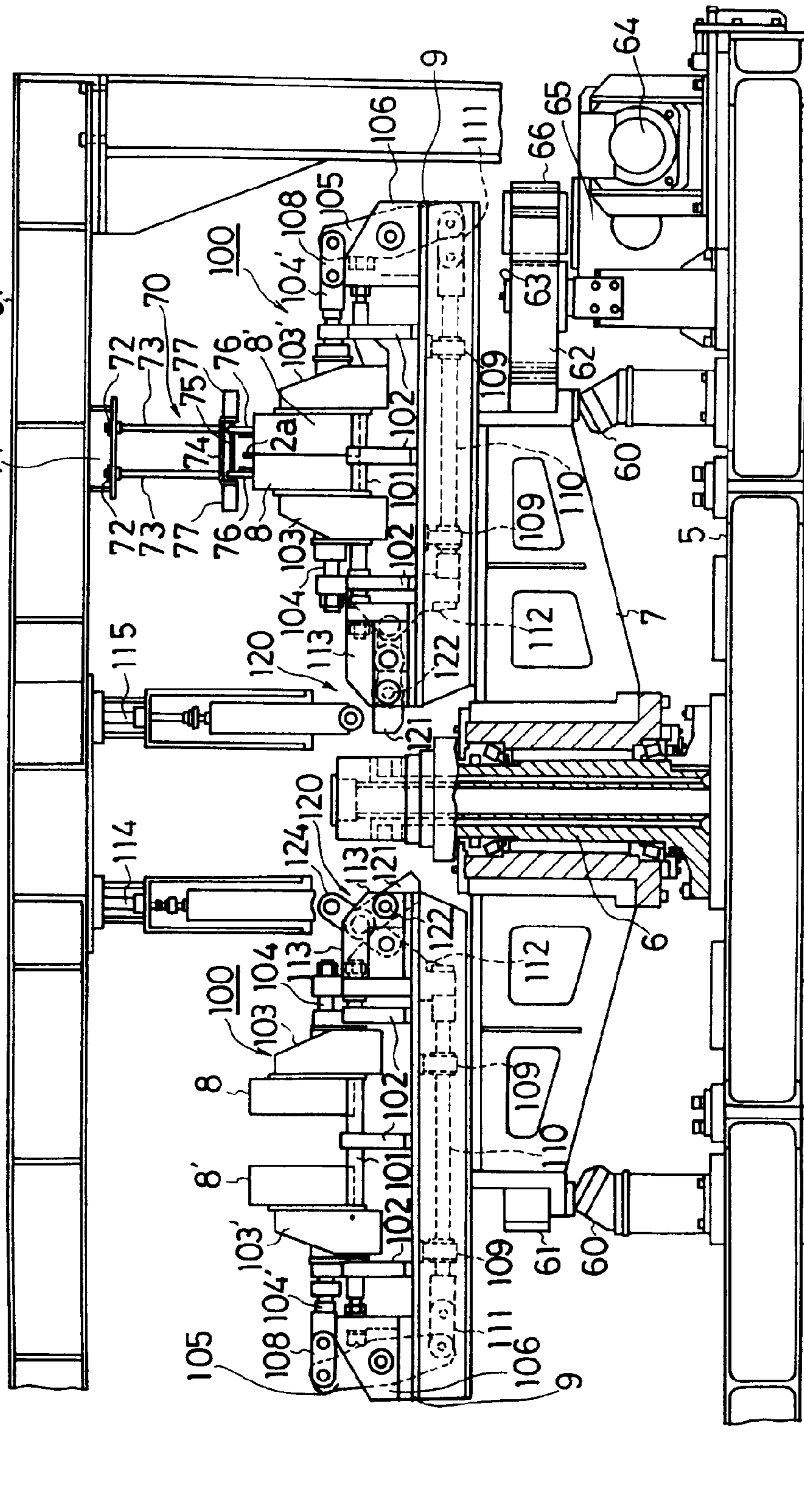

67
72
73
70
77
75
76
74
71
2a
8
8'
103'
103
104'
104
100
108
105
106
9
111
66
65
64
63
62
60
61
109
110
102
101
5
7
112
113
122
120
121
115
114
124
6

FIG.9

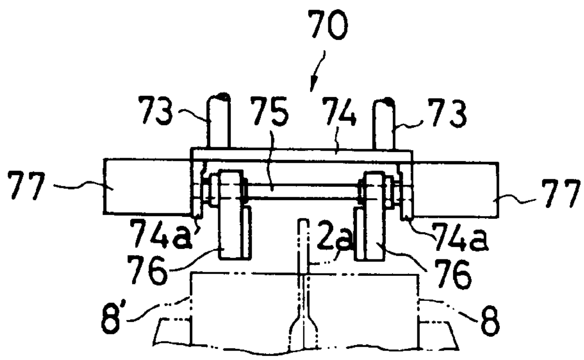

70
73
75
74
73
77
77
74a
2a
74a
76
76
8'
8

FIG.10

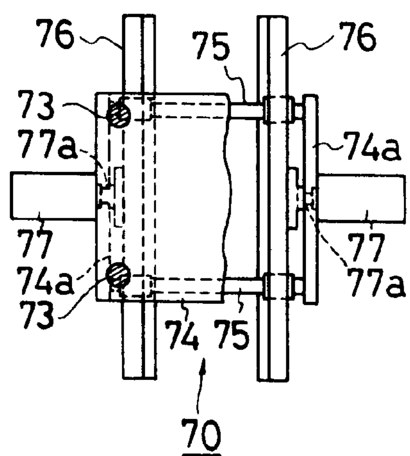

76
75
76
73
77a
74a
77
77
74a
77a
73
74
75
70

FIG.11

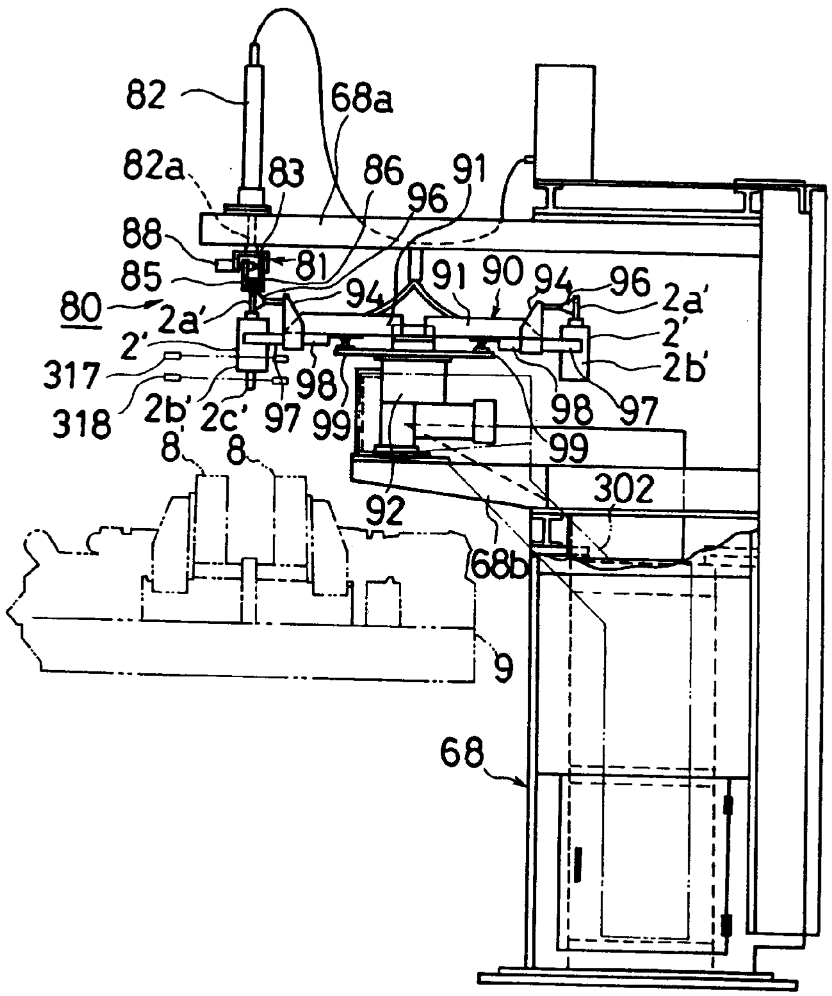

82
68a
82a
83
86
96
91
88
81
85
80
2a'
94
91
90
94
96
2a'
2'
2b'
317
2'
98
98
97
318
2b'
2c'
97
99
99
8
8
92
302
68b
9
68

FIG.12

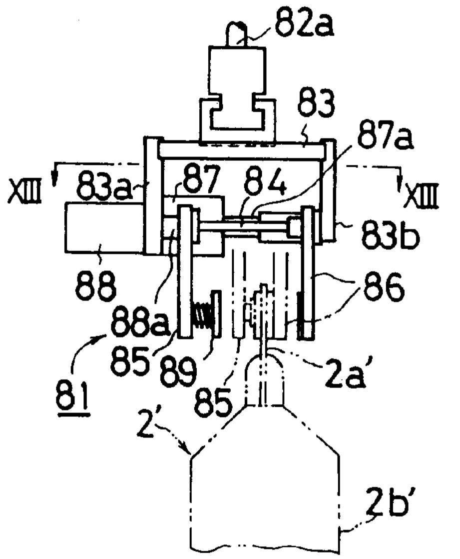


FIG.13

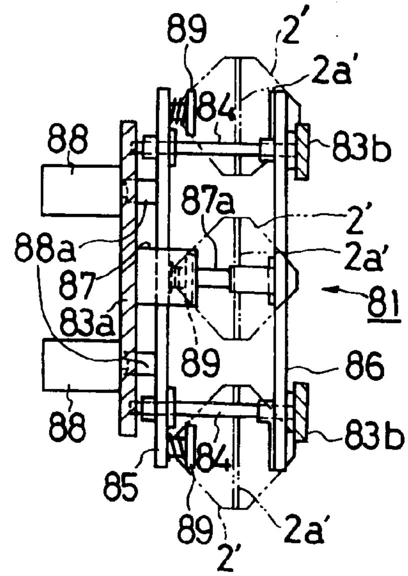


FIG.14

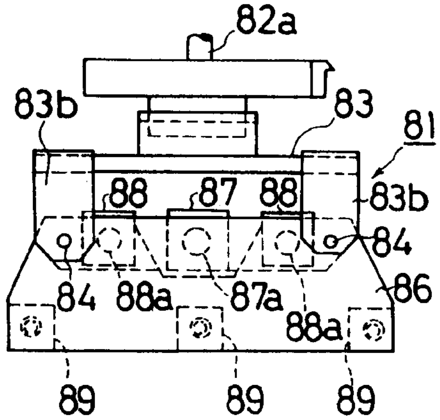


FIG.15

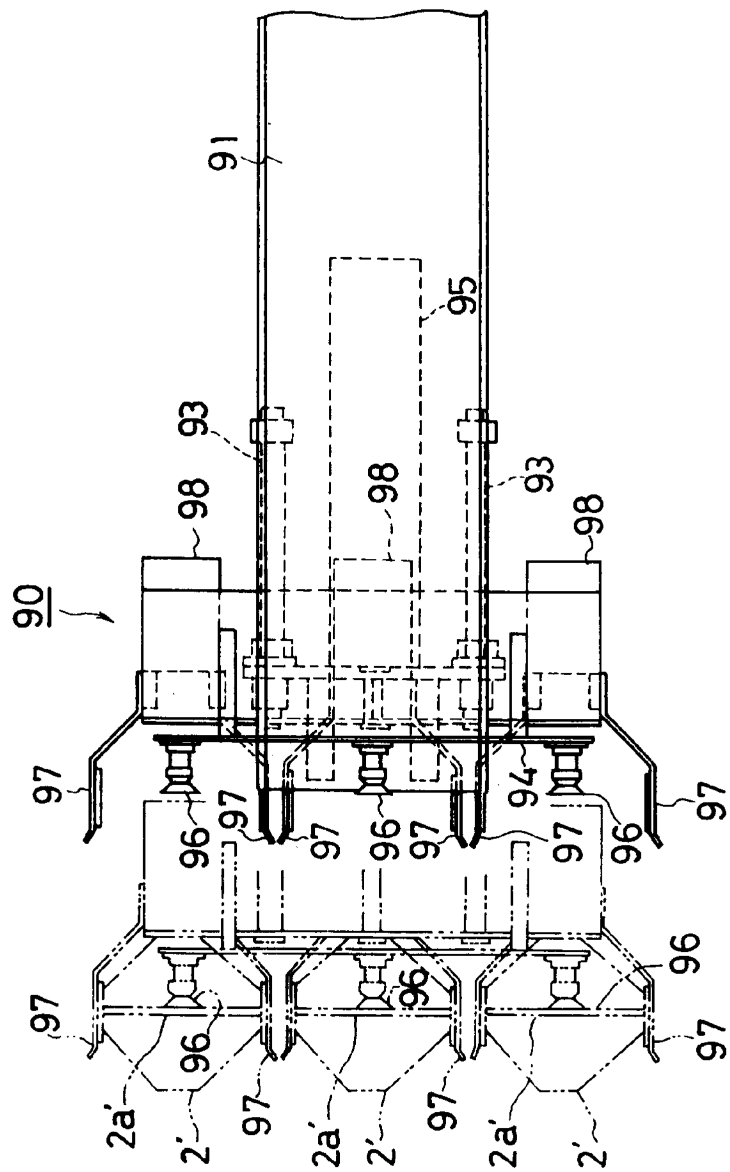

90
91
95
93
93
98
98
98
97
97
97
97
97
97
94
96
96
96
96
96
96
97
97
97
97
2a'
2'
2a'
2'
2a'
2'

FIG.16

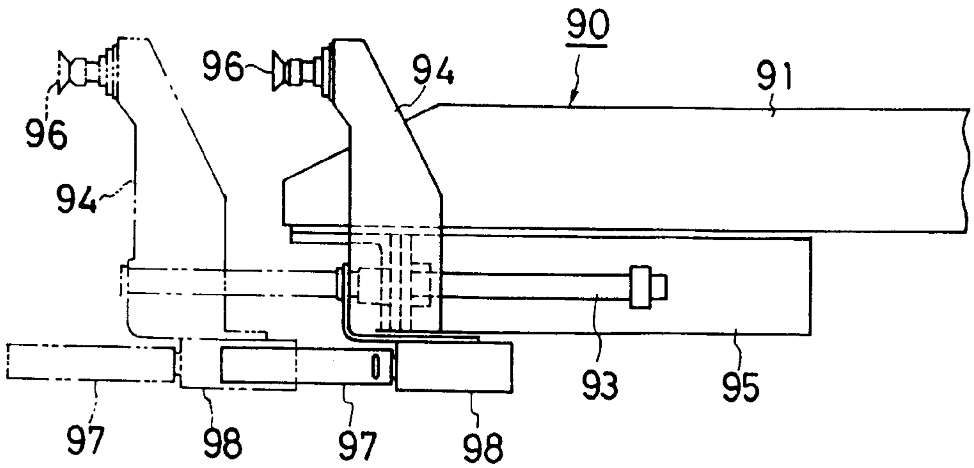

90
96
94
91
96
94
93
95
97
98
97
98

FIG.17

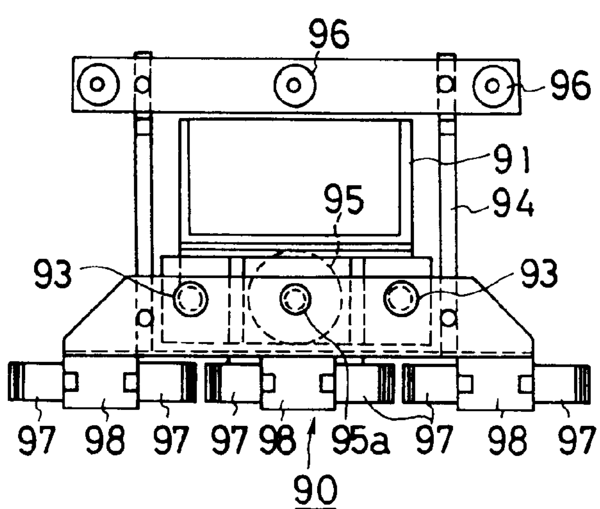

96
96
91
95
94
93
93
97
98
97
97
98
95a
97
98
97
90

FIG.18

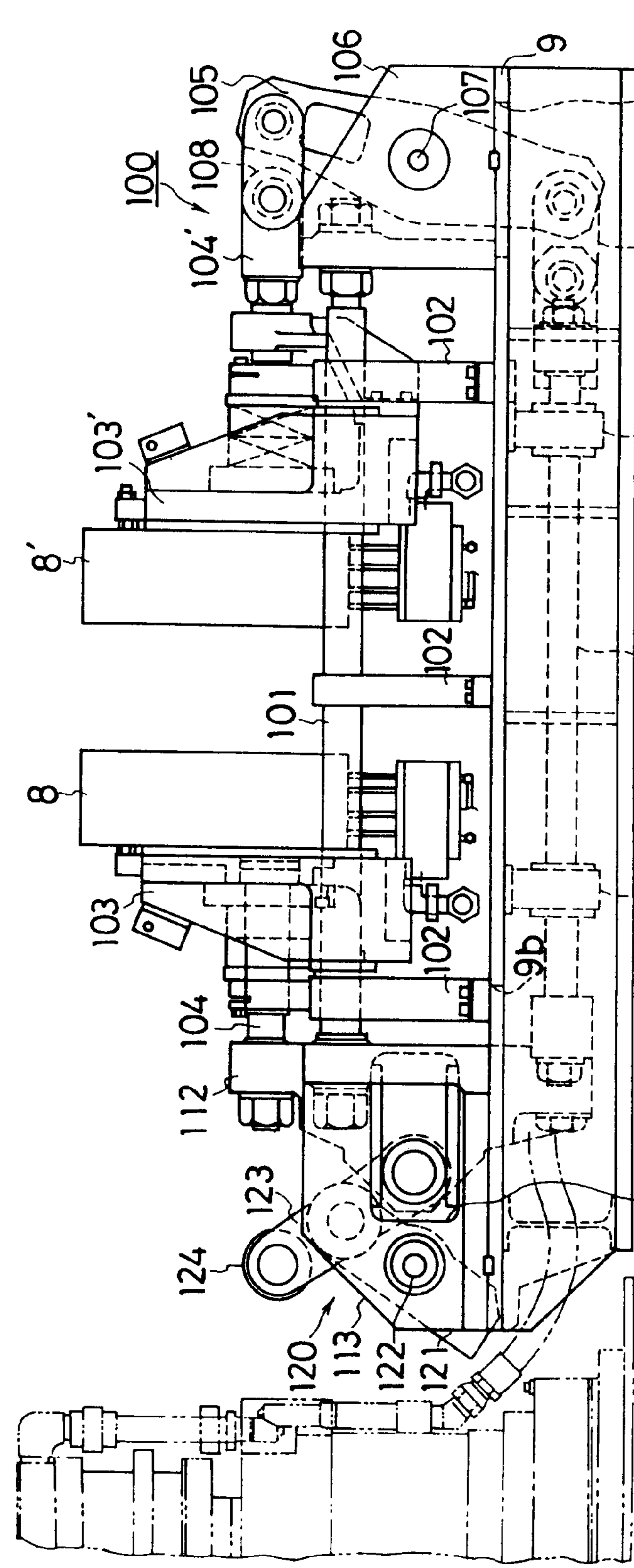

100
104'
108
105
106
107
9
9a
111
102
103'
109
8'
110
102
101
8
109
103
102
9b
104
112
123
124
113a
120
113
122
121

FIG.19

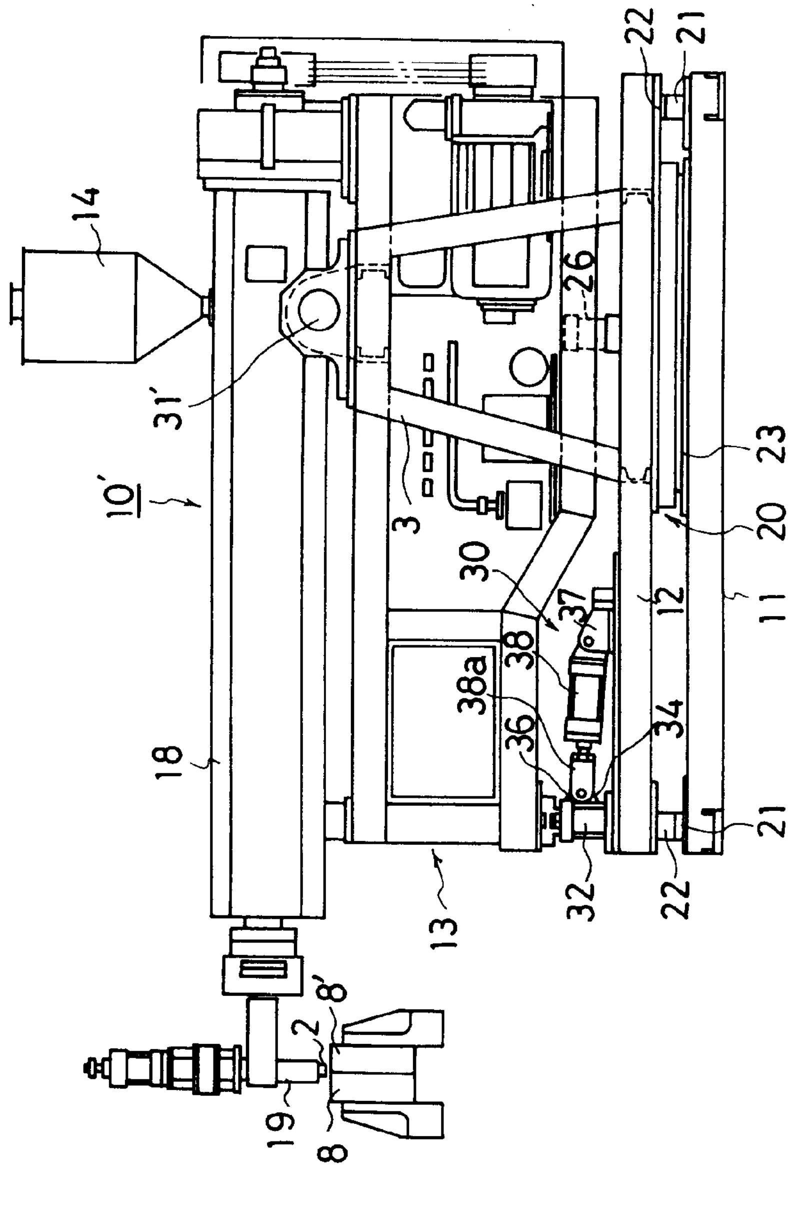


FIG.20B

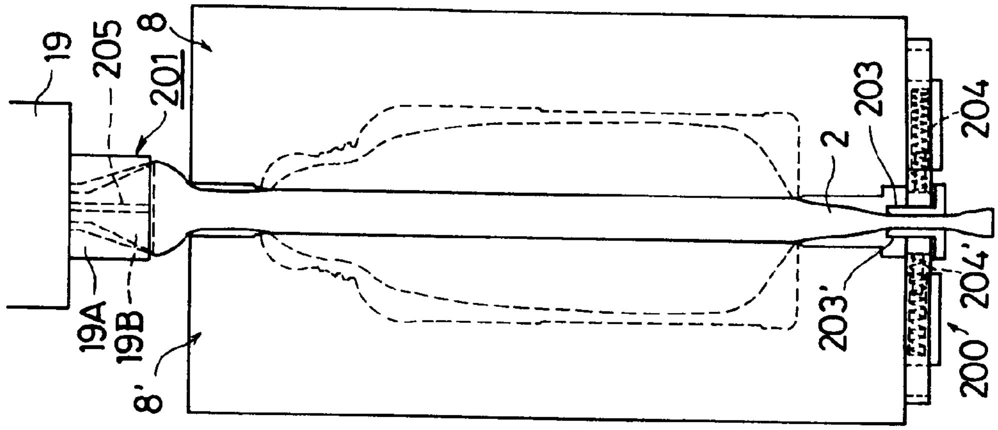


FIG.20A

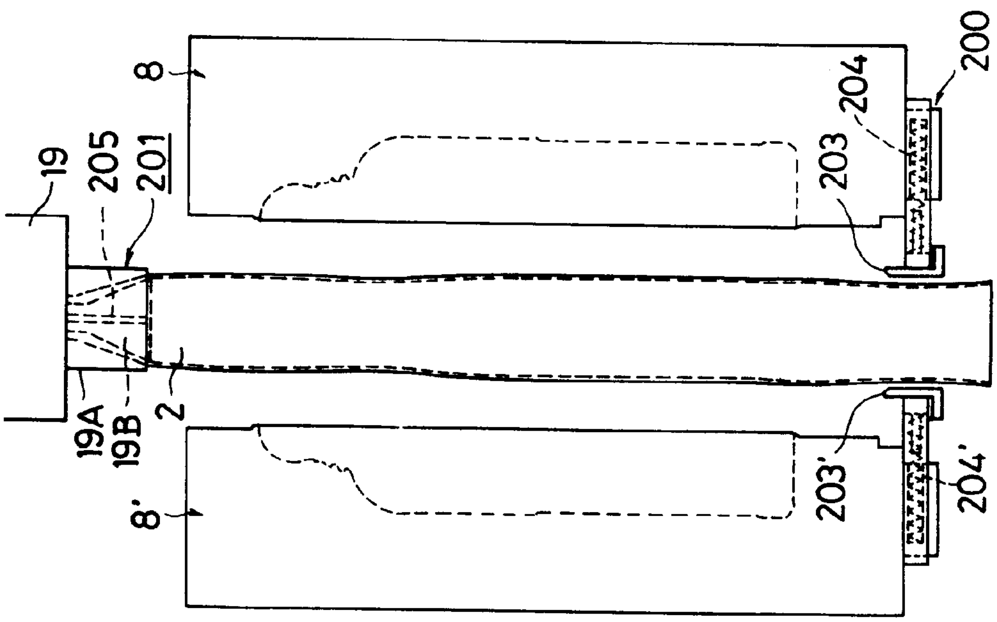


FIG.21A

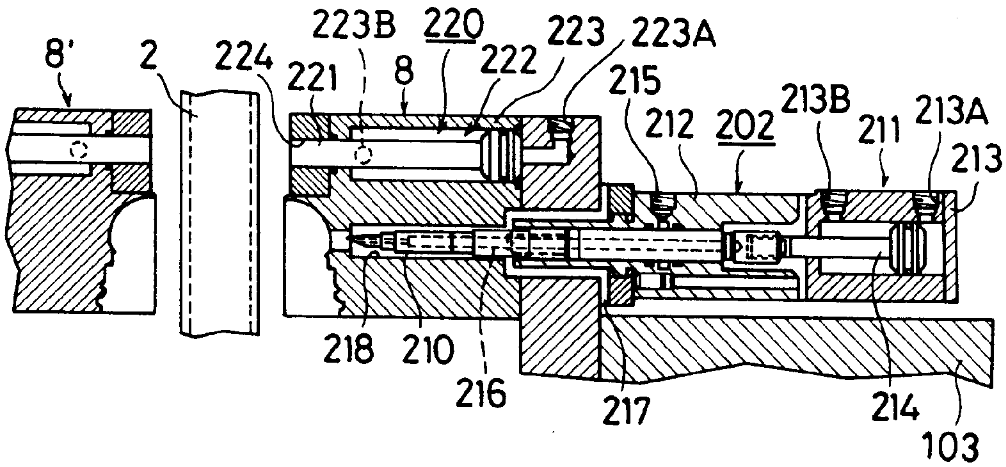


FIG.21B

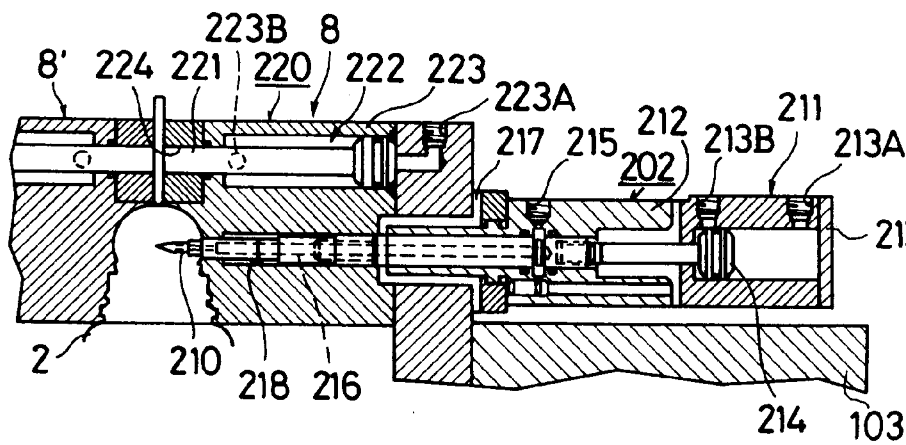


FIG.21C

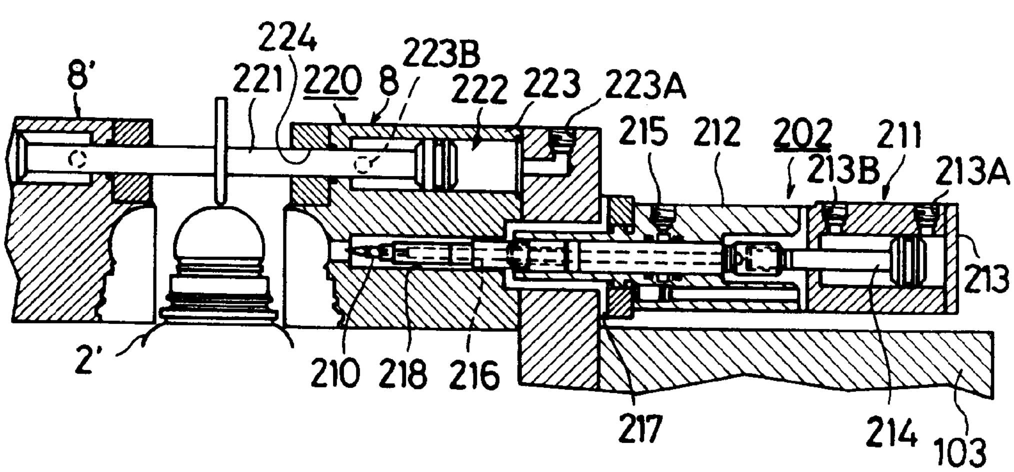


FIG.22

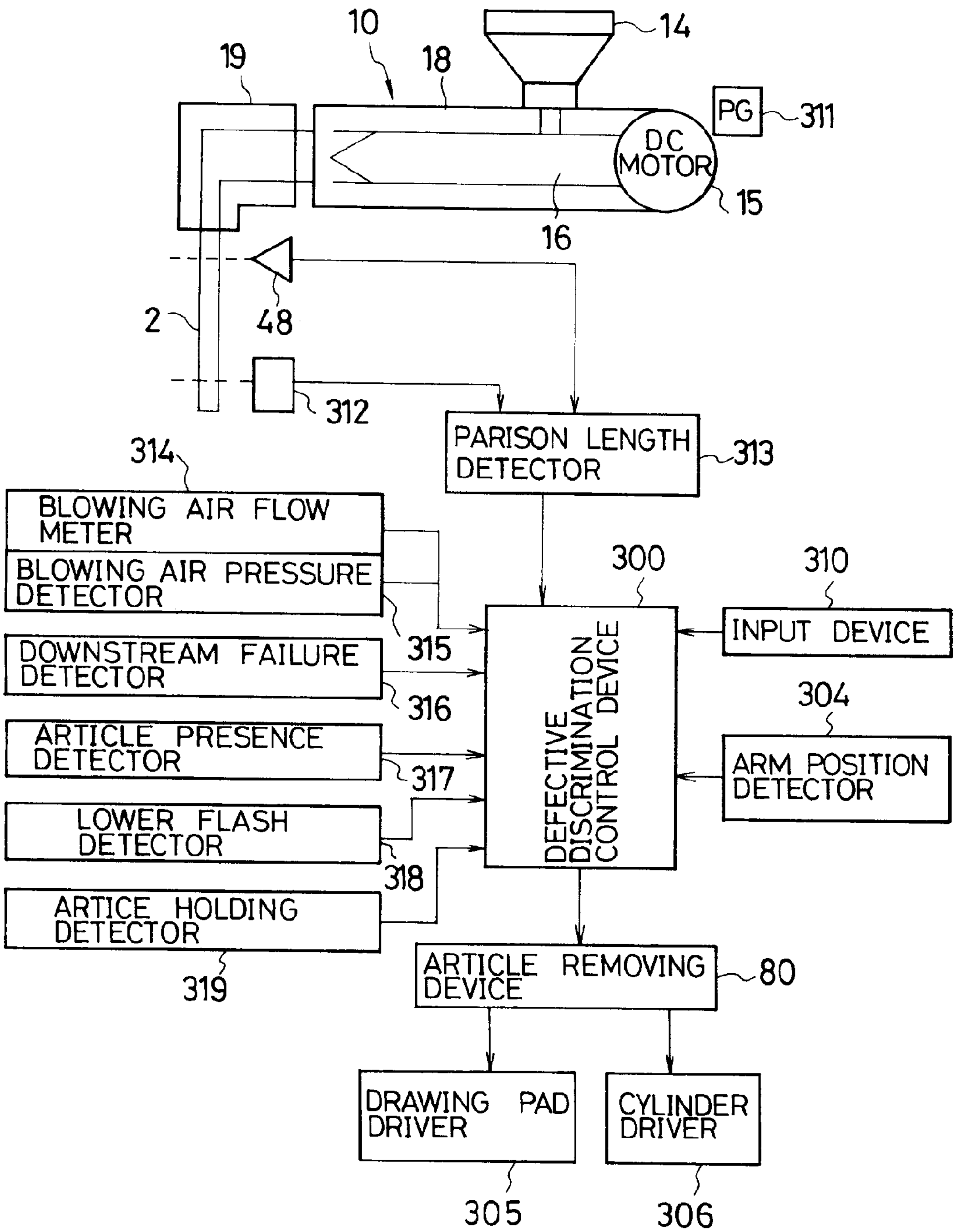

10
19
18
14
PG
311
DC MOTOR
15
16
48
2
312
PARISON LENGTH DETECTOR
313
314
BLOWING AIR FLOW METER
BLOWING AIR PRESSURE DETECTOR
315
DOWNSTREAM FAILURE DETECTOR
316
ARTICLE PRESENCE DETECTOR
317
LOWER FLASH DETECTOR
318
ARTICE HOLDING DETECTOR
319
300
DEFECTIVE DISCRIMINATION CONTROL DEVICE
310
INPUT DEVICE
304
ARM POSITION DETECTOR
ARTICLE REMOVING DEVICE
80
DRAWING PAD DRIVER
CYLINDER DRIVER
305
306

FIG.23

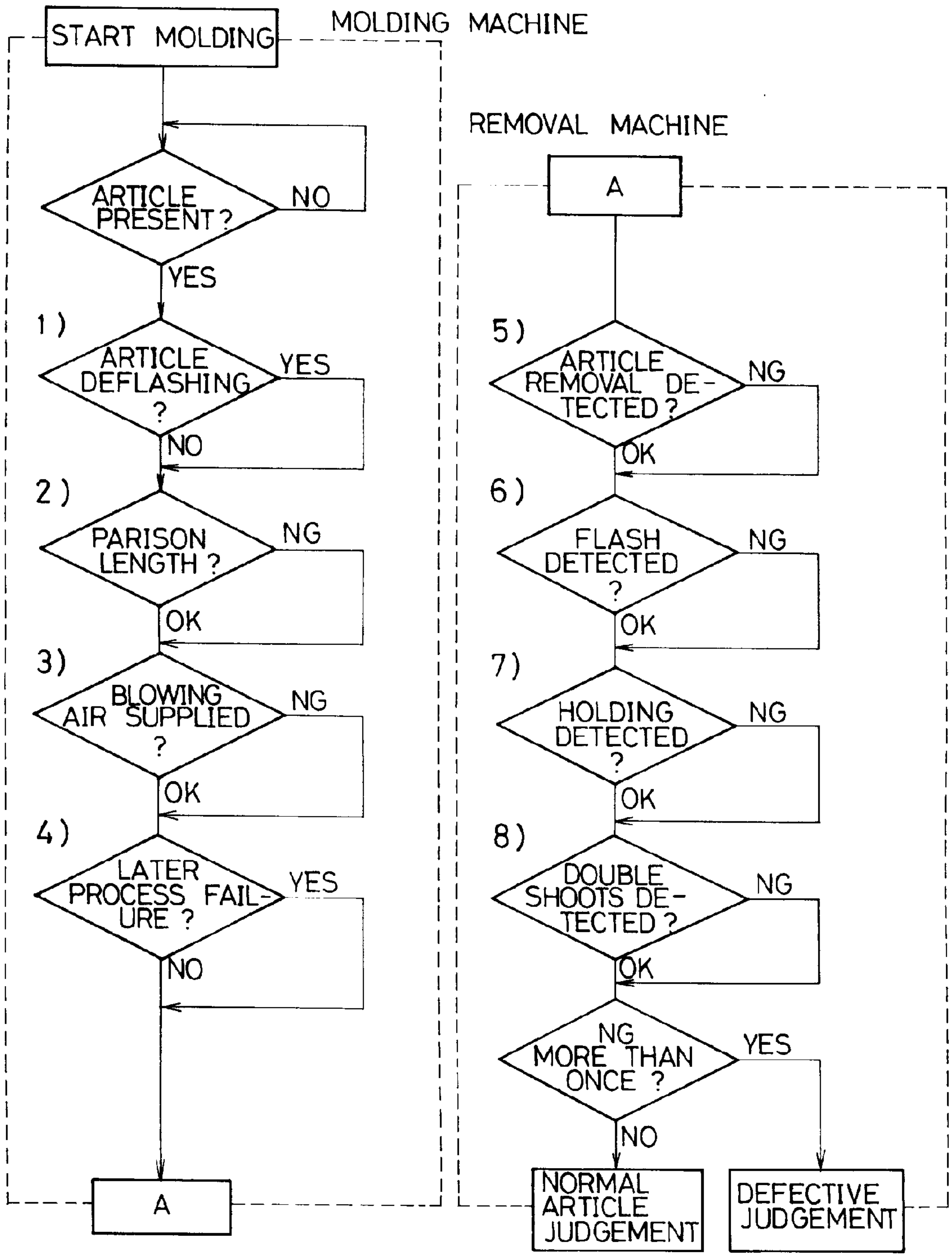

START MOLDING
MOLDING MACHINE
ARTICLE PRESENT ?
NO
YES
1)
ARTICLE DEFLASHING ?
YES
NO
2)
PARISON LENGTH ?
NG
OK
3)
BLOWING AIR SUPPLIED ?
NG
OK
4)
LATER PROCESS FAIL-URE ?
YES
NO
A
REMOVAL MACHINE
A
5)
ARTICLE REMOVAL DE-TECTED ?
NG
OK
6)
FLASH DETECTED ?
NG
OK
7)
HOLDING DETECTED ?
NG
OK
8)
DOUBLE SHOOTS DE-TECTED ?
NG
OK
NG MORE THAN ONCE ?
YES
NO
NORMAL ARTICLE JUDGEMENT
DEFECTIVE JUDGEMENT

FIG.24

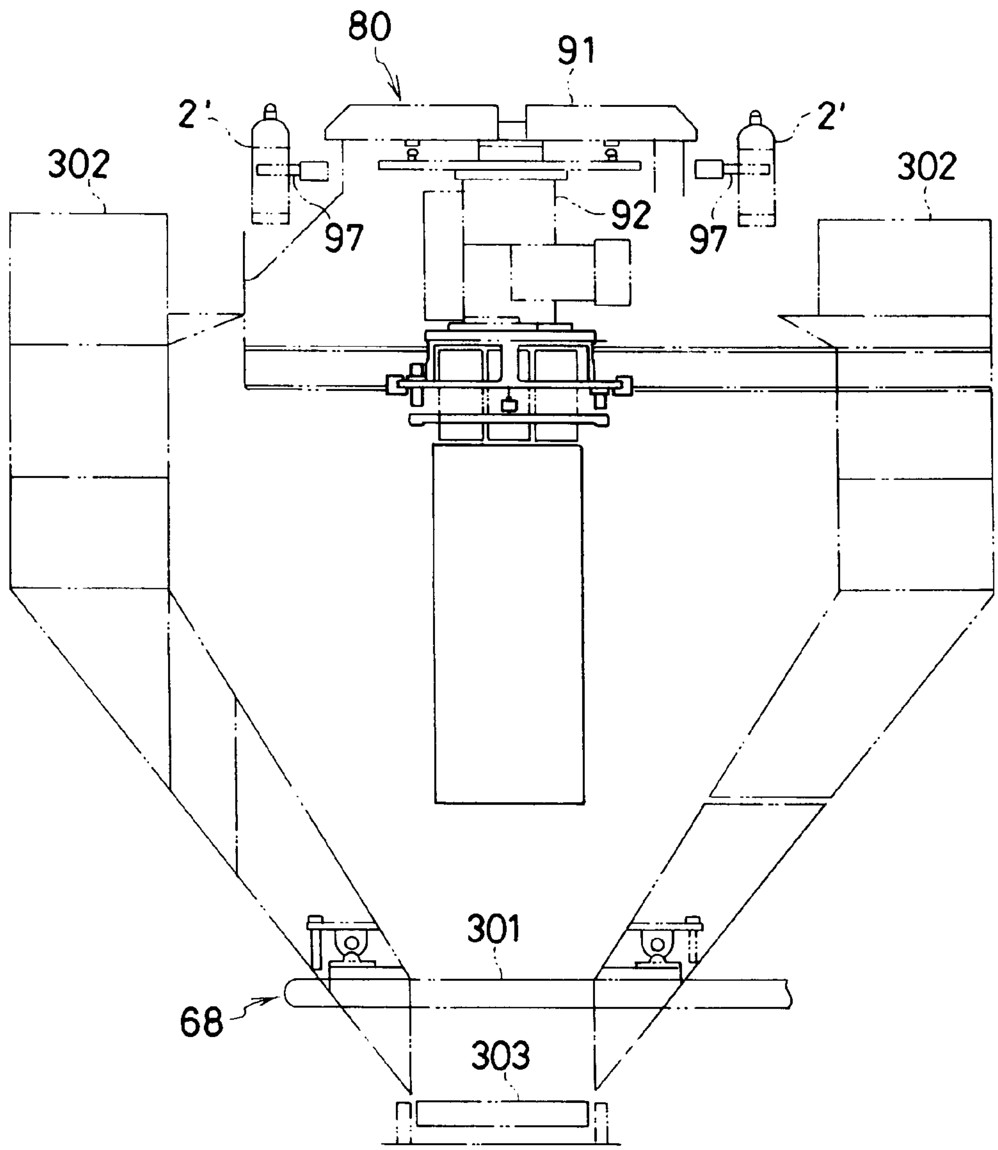


FIG.25

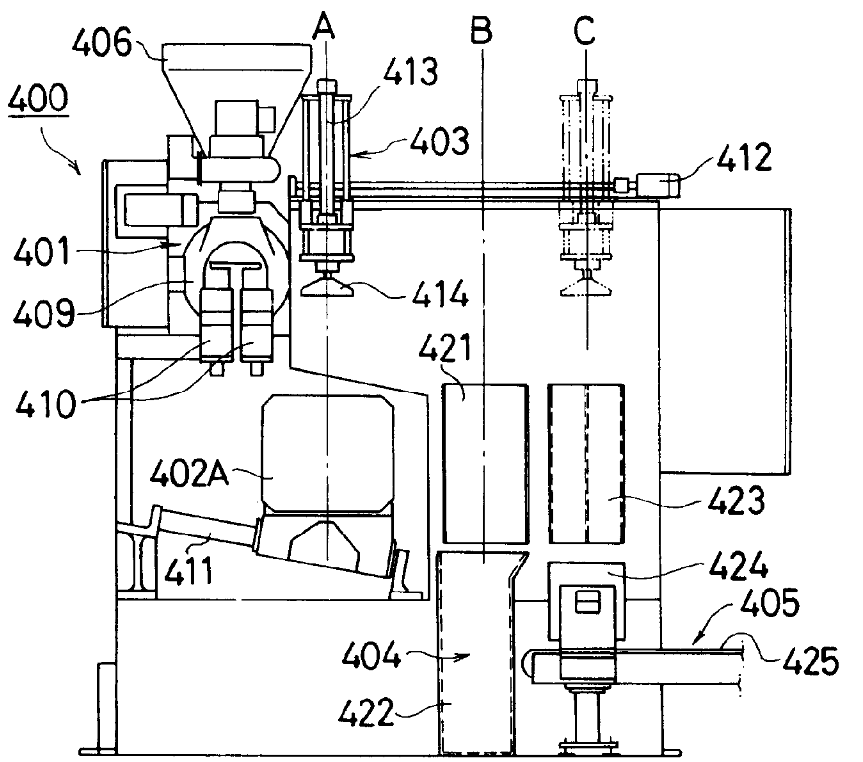

A
B
C
406
413
400
403
412
401
409
414
421
410
402A
423
411
424
405
404
425
422

FIG.26

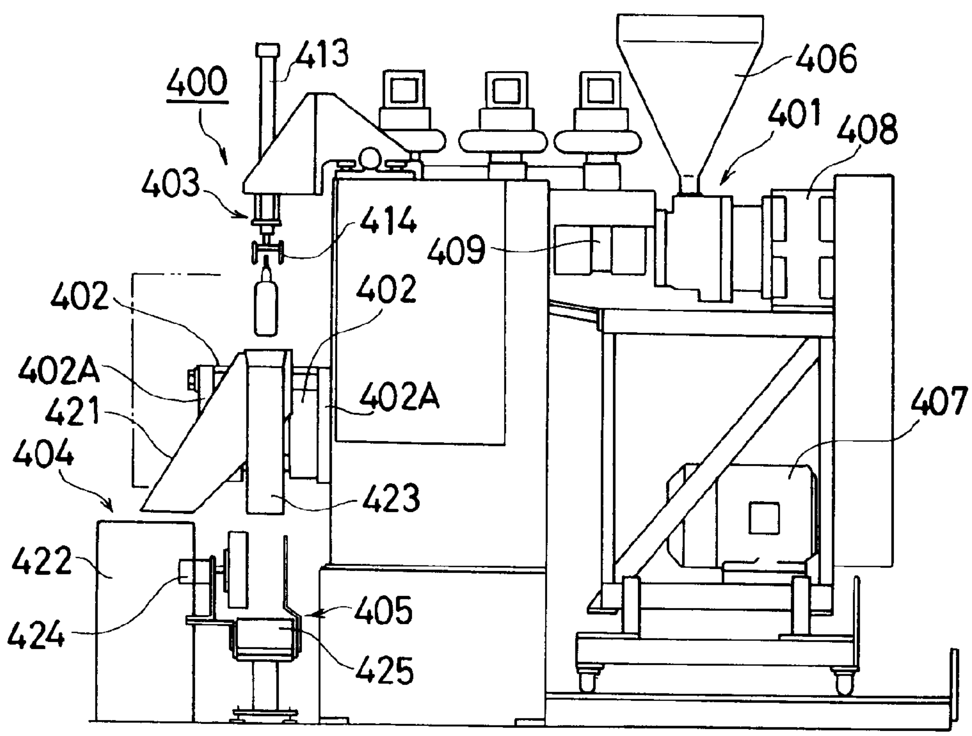

413
406
400
401
408
403
414
409
402
402
402A
402A
407
421
404
423
422
405
424
425

FIG.27

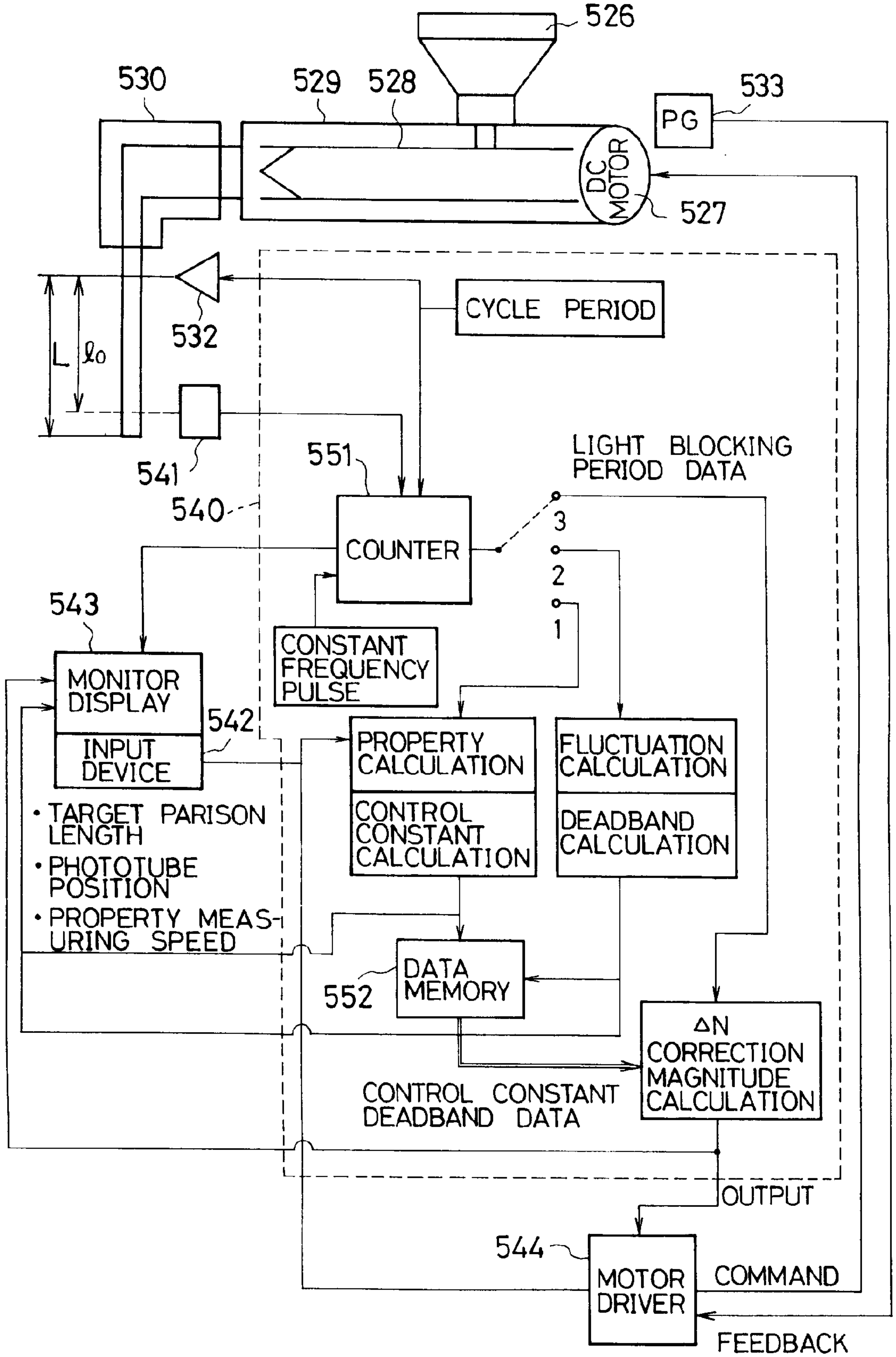

526
530
529
528
533
PG
DC MOTOR
527
532
CYCLE PERIOD
L
ℓ_0
541
551
540
LIGHT BLOCKING PERIOD DATA
COUNTER
3
2
1
543
CONSTANT FREQUENCY PULSE
MONITOR DISPLAY
INPUT DEVICE
542
PROPERTY CALCULATION
CONTROL CONSTANT CALCULATION
FLUCTUATION CALCULATION
DEADBAND CALCULATION
• TARGET PARISON LENGTH
• PHOTOTUBE POSITION
• PROPERTY MEASURING SPEED
DATA MEMORY
552
ΔN CORRECTION MAGNITUDE CALCULATION
CONTROL CONSTANT DEADBAND DATA
OUTPUT
544
MOTOR DRIVER
COMMAND
FEEDBACK

FIG.28

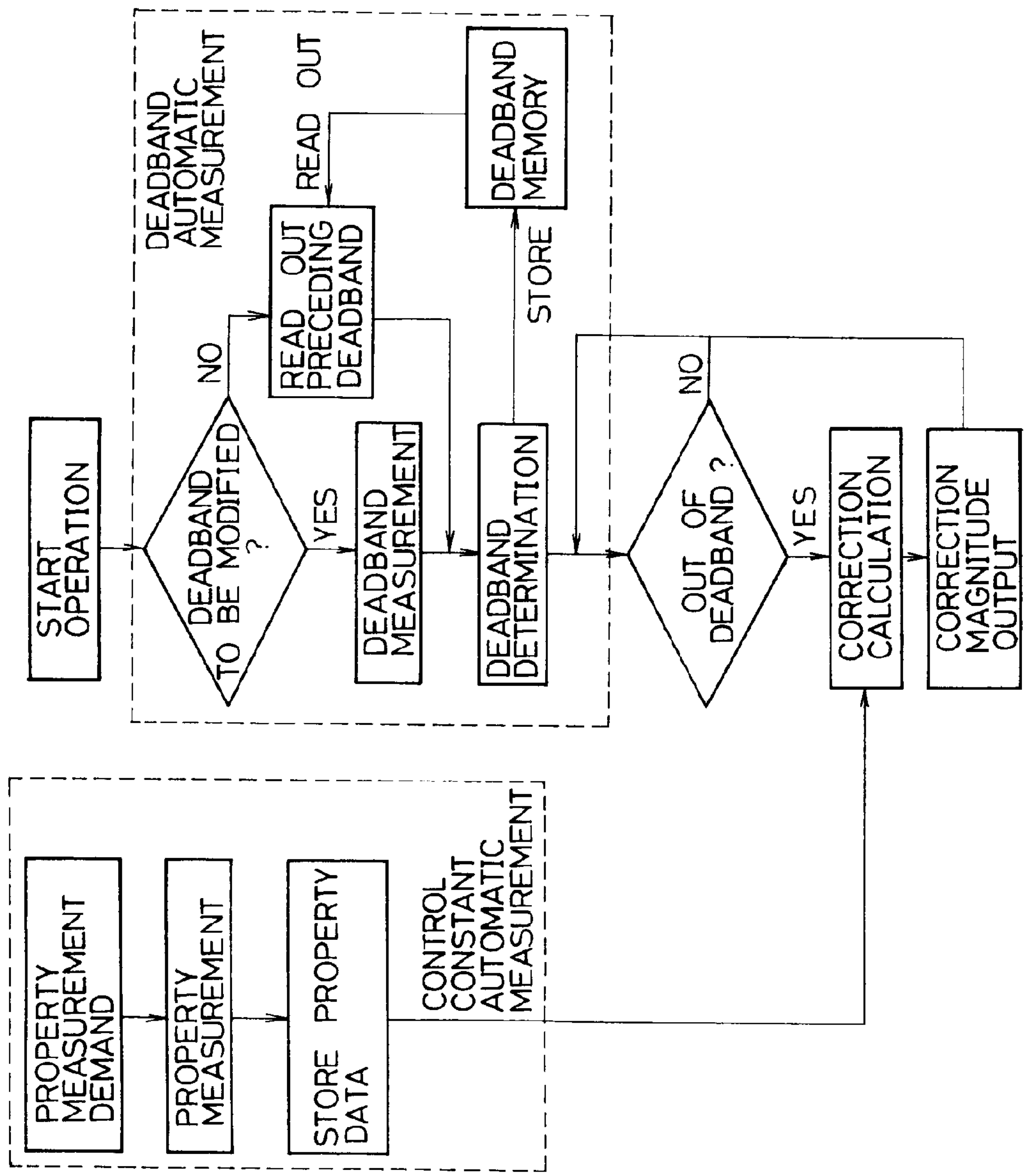

START OPERATION
DEADBAND AUTOMATIC MEASUREMENT
DEADBAND TO BE MODIFIED ?
YES
NO
READ OUT PRECEDING DEADBAND
READ OUT
DEADBAND MEMORY
DEADBAND MEASUREMENT
DEADBAND DETERMINATION
STORE
OUT OF DEADBAND ?
NO
YES
CORRECTION CALCULATION
CORRECTION MAGNITUDE OUTPUT
PROPERTY MEASUREMENT DEMAND
PROPERTY MEASUREMENT
STORE PROPERTY DATA
CONTROL CONSTANT AUTOMATIC MEASUREMENT

FIG.29

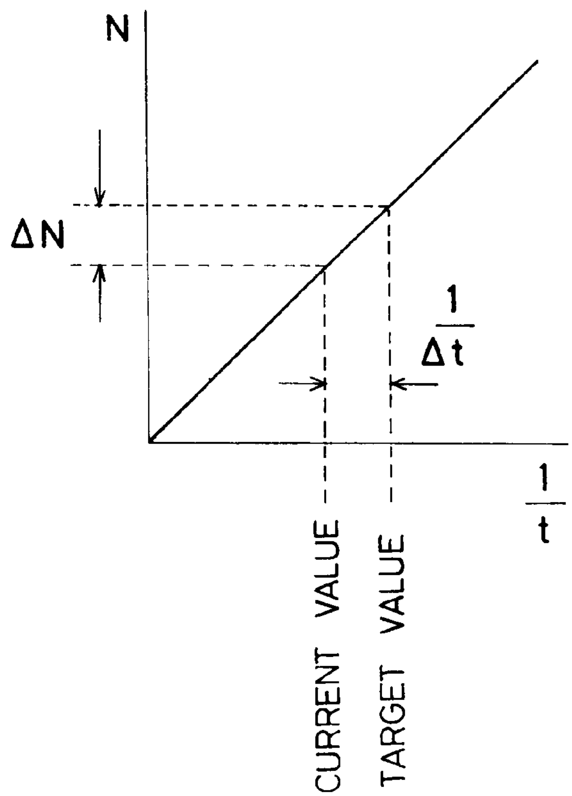


FIG.30

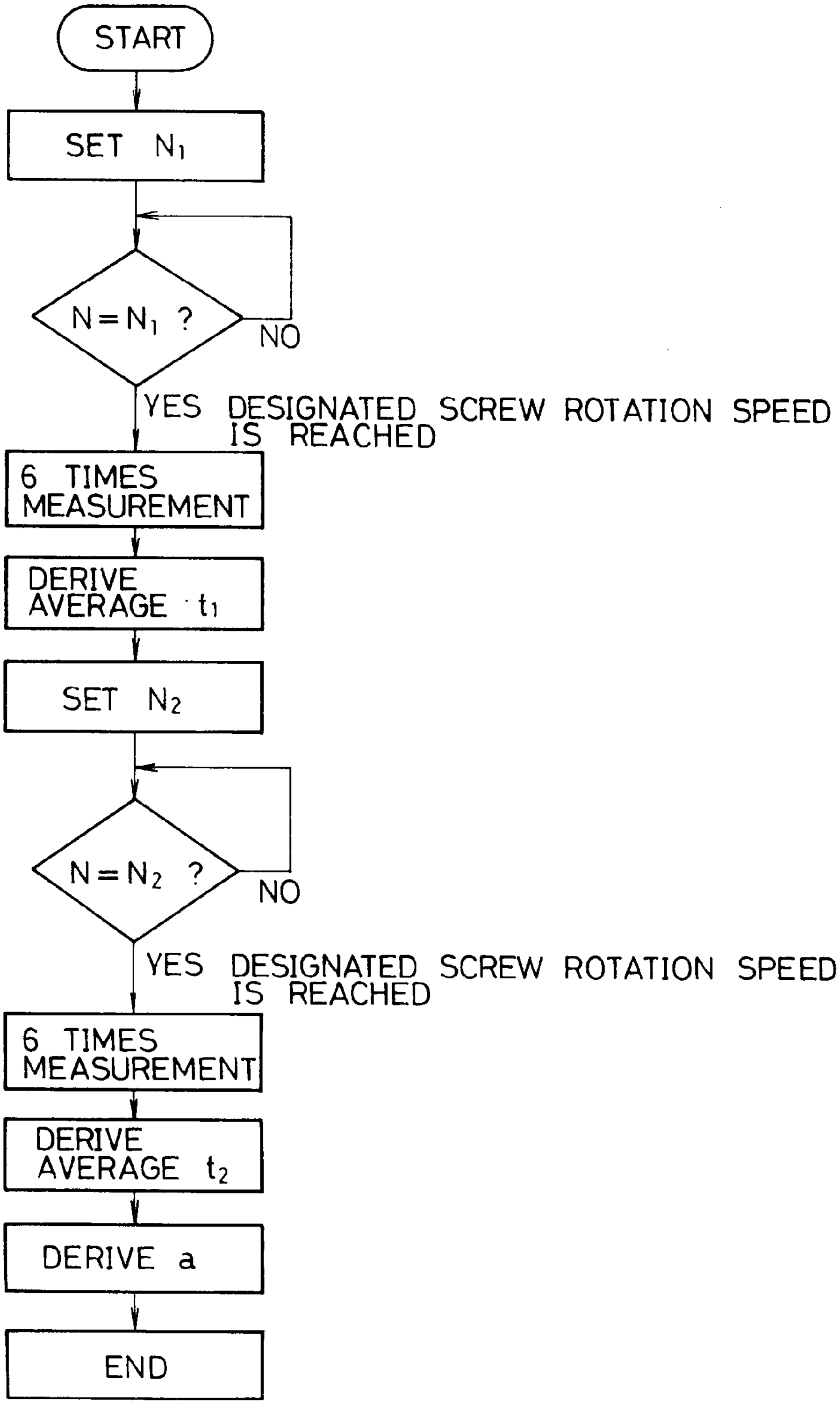

START
SET N_1
$N=N_1$?
NO
YES
DESIGNATED SCREW ROTATION SPEED IS REACHED
6 TIMES MEASUREMENT
DERIVE AVERAGE t_1
SET N_2
$N=N_2$?
NO
YES
DESIGNATED SCREW ROTATION SPEED IS REACHED
6 TIMES MEASUREMENT
DERIVE AVERAGE t_2
DERIVE a
END

FIG.31A

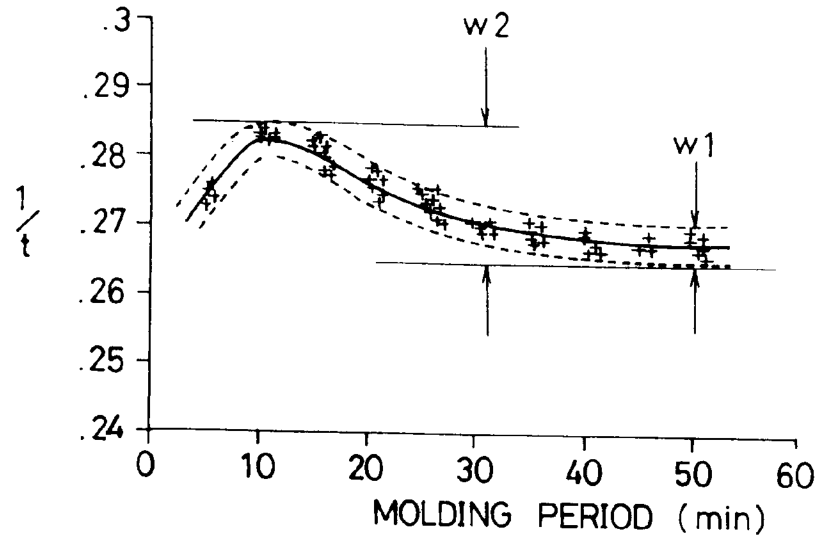


FIG.31B

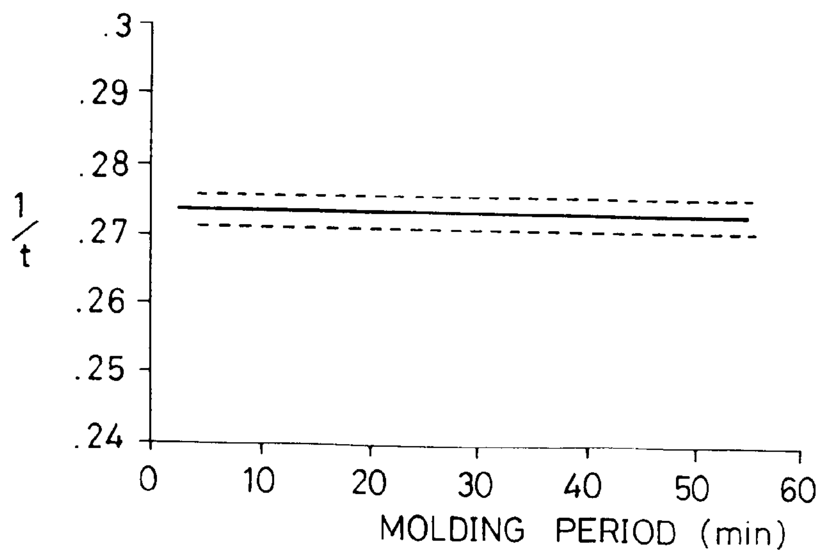


FIG.32A

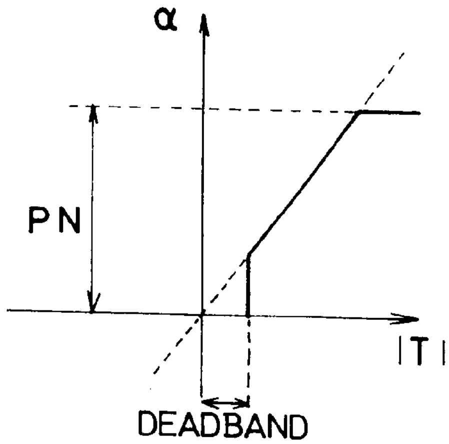


FIG.32B

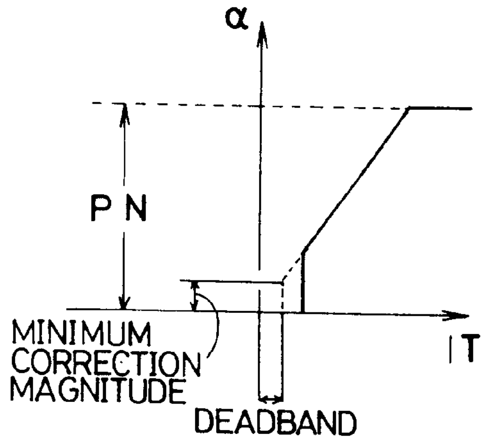


FIG.32C

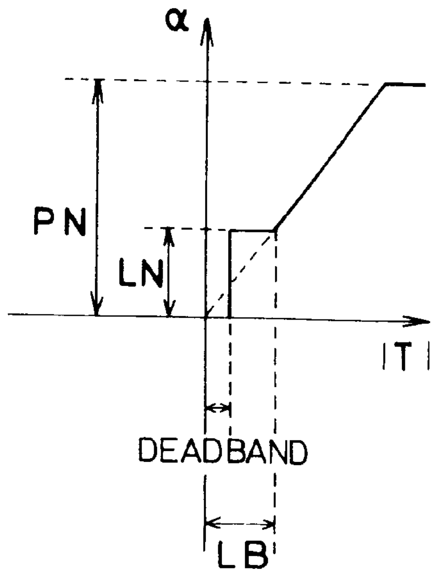


FIG.33

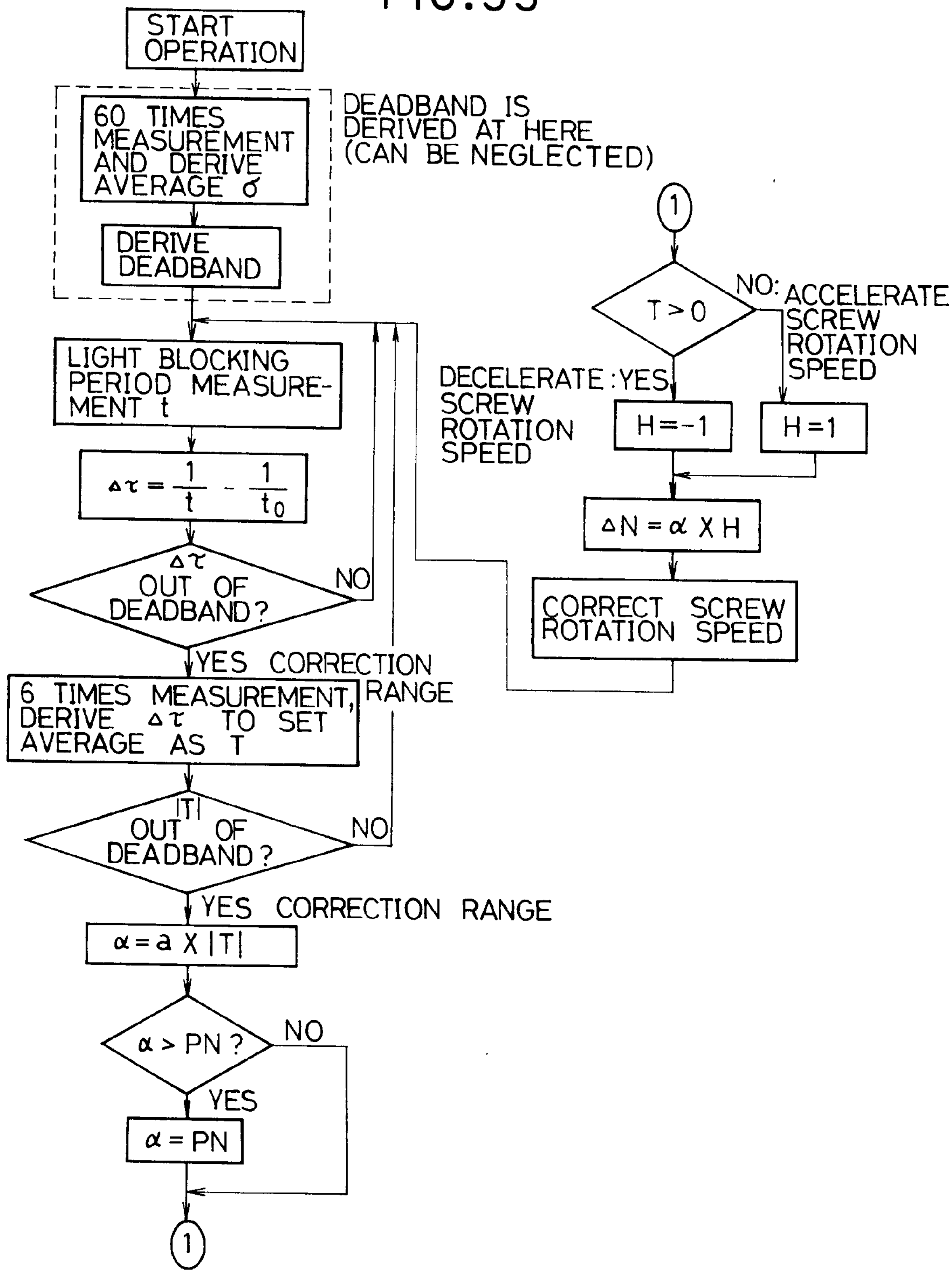

START OPERATION
60 TIMES MEASUREMENT AND DERIVE AVERAGE σ
DERIVE DEADBAND
DEADBAND IS DERIVED AT HERE (CAN BE NEGLECTED)
LIGHT BLOCKING PERIOD MEASUREMENT t
Δτ = 1/t - 1/t0
Δτ OUT OF DEADBAND?
NO
YES CORRECTION RANGE
6 TIMES MEASUREMENT, DERIVE Δτ TO SET AVERAGE AS T
|T| OUT OF DEADBAND?
NO
YES CORRECTION RANGE
α = a X |T|
α > PN ?
NO
YES
α = PN
1
1
T > 0
NO: ACCELERATE SCREW ROTATION SPEED
DECELERATE SCREW ROTATION SPEED : YES
H = -1
H = 1
ΔN = α X H
CORRECT SCREW ROTATION SPEED

FIG.34

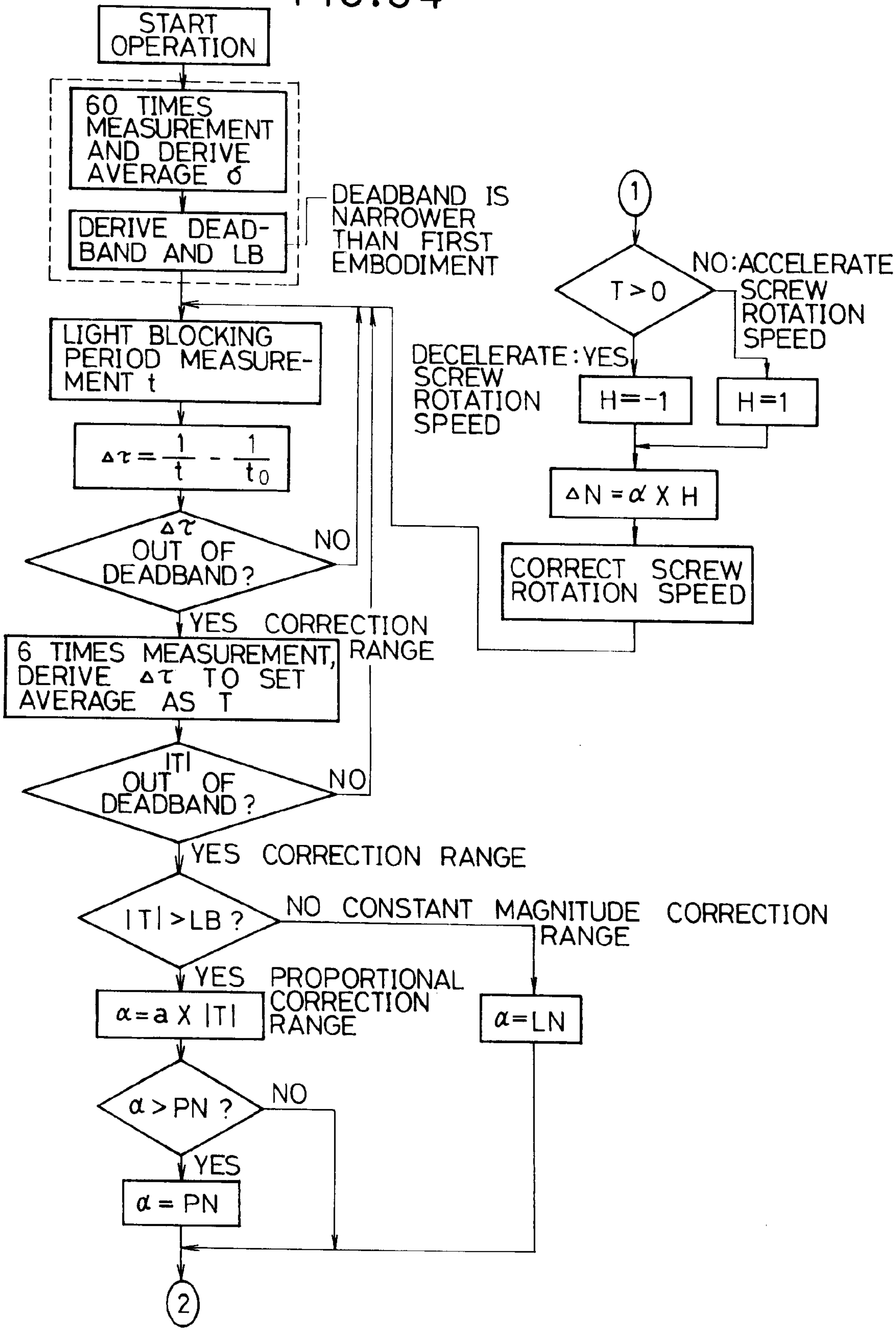
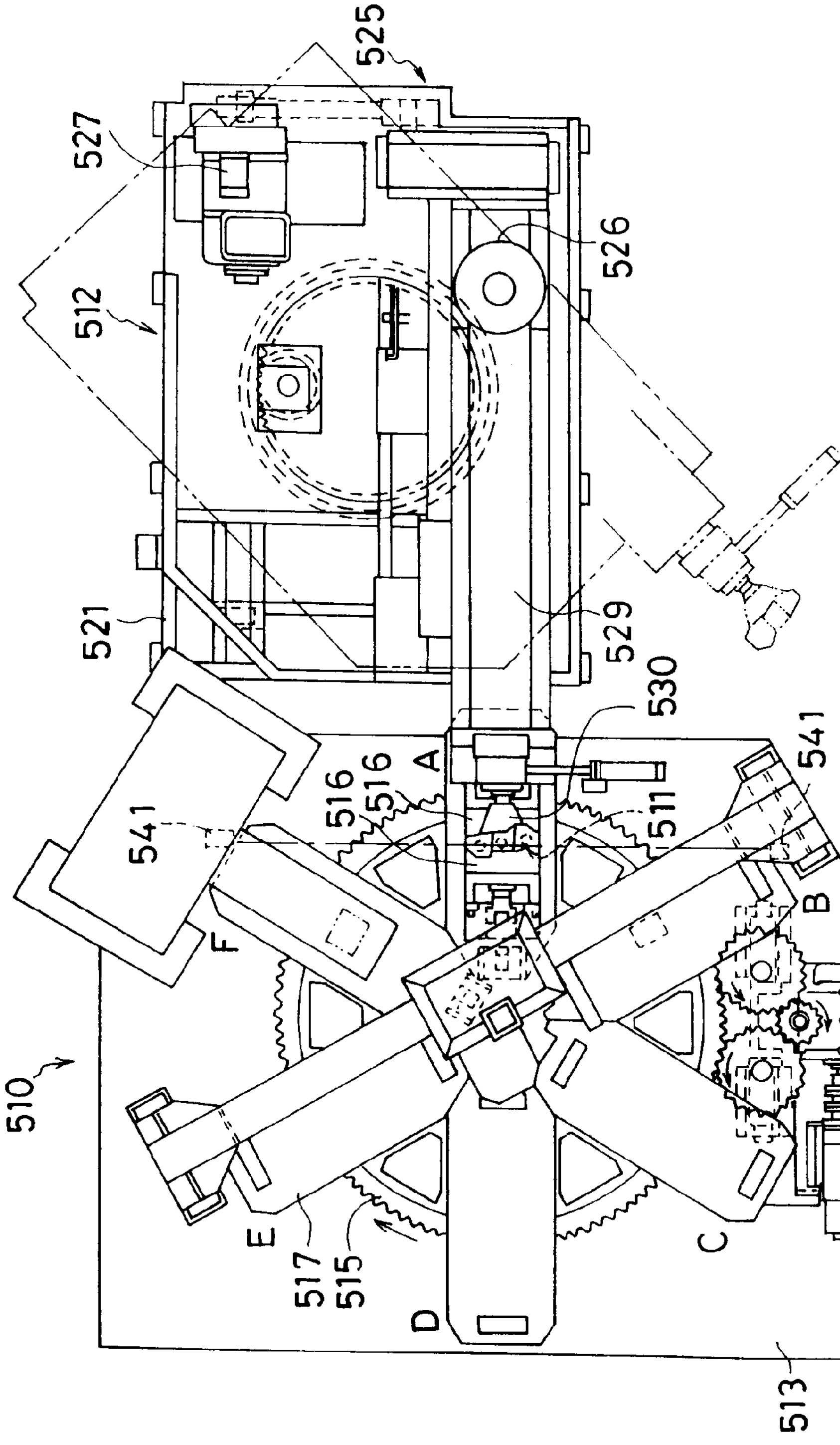

START OPERATION
60 TIMES MEASUREMENT AND DERIVE AVERAGE σ
DERIVE DEAD-BAND AND LB
DEADBAND IS NARROWER THAN FIRST EMBODIMENT
LIGHT BLOCKING PERIOD MEASURE-MENT t
Δτ = 1/t - 1/t0
Δτ OUT OF DEADBAND?
NO
YES CORRECTION RANGE
6 TIMES MEASUREMENT, DERIVE Δτ TO SET AVERAGE AS T
|T| OUT OF DEADBAND?
NO
YES CORRECTION RANGE
|T|>LB ?
NO CONSTANT MAGNITUDE CORRECTION RANGE
YES PROPORTIONAL CORRECTION RANGE
α=a X |T|
α=LN
α > PN ?
NO
YES
α = PN
2
1
T > 0
NO:ACCELERATE SCREW ROTATION SPEED
DECELERATE:YES SCREW ROTATION SPEED
H=-1
H=1
ΔN = α X H
CORRECT SCREW ROTATION SPEED

FIG.35



7/17/08, EAST Version: 2.2.1.0

FIG.36

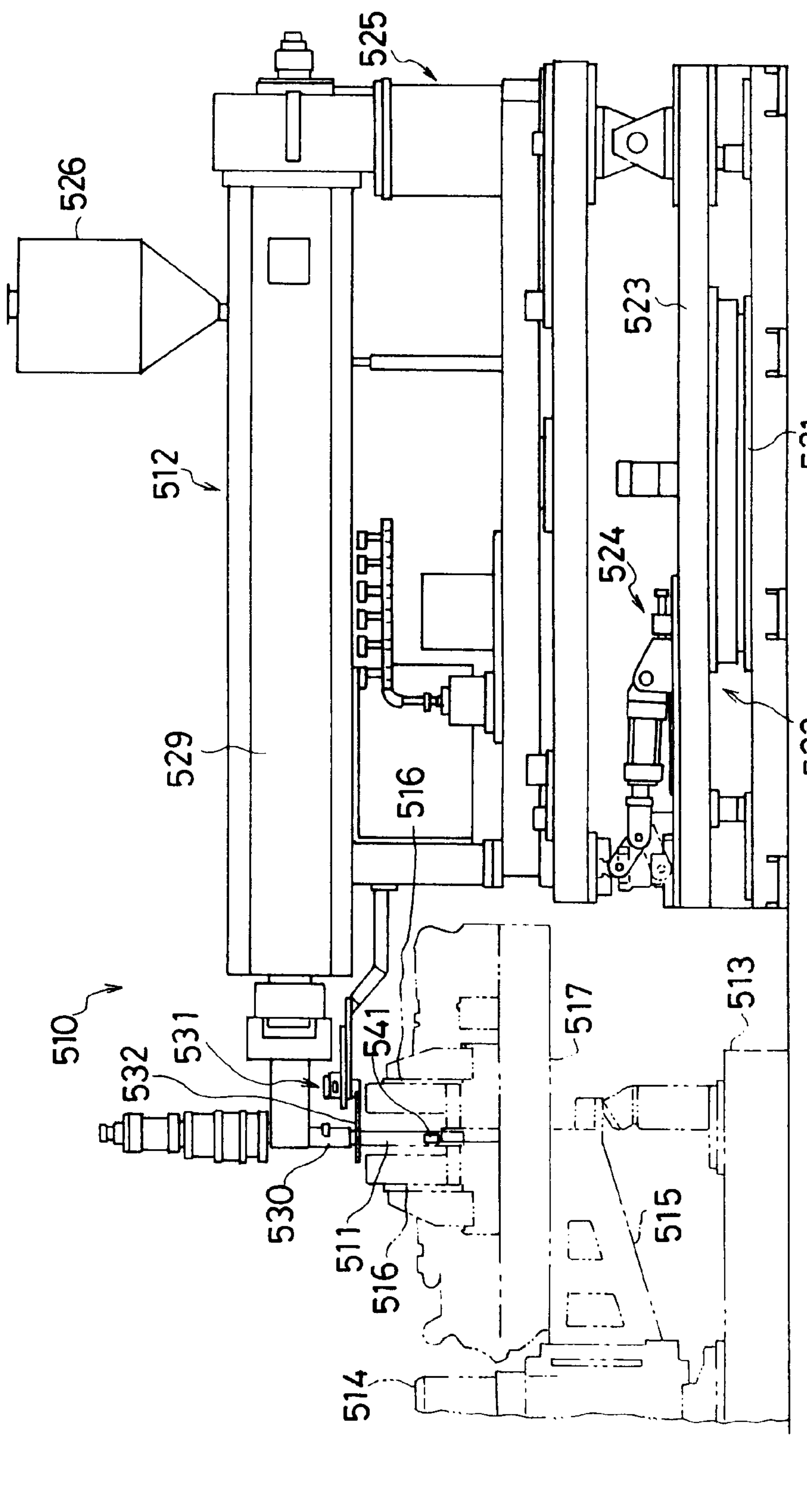
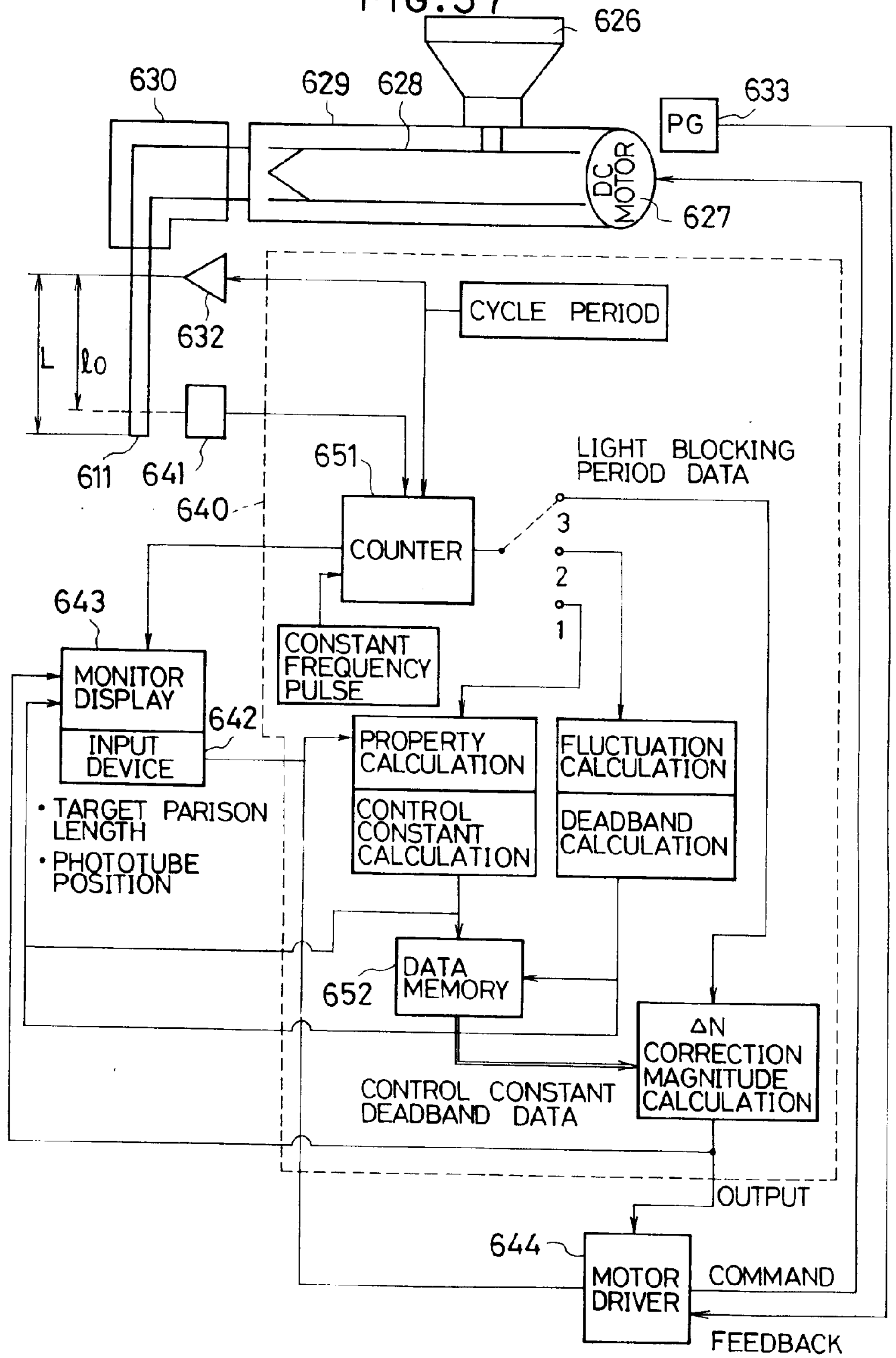

526
525
512
529
523
521
524
522
516
510
531
532
541
517
513
530
511
516
515
514

FIG.37



626
630
629
628
633
PG
DC MOTOR
627
CYCLE PERIOD
632
L
ℓo
611
641
651
640
LIGHT BLOCKING PERIOD DATA
COUNTER
3
2
1
643
MONITOR DISPLAY
INPUT DEVICE
642
CONSTANT FREQUENCY PULSE
PROPERTY CALCULATION
CONTROL CONSTANT CALCULATION
FLUCTUATION CALCULATION
DEADBAND CALCULATION
• TARGET PARISON LENGTH
• PHOTOTUBE POSITION
DATA MEMORY
652
ΔN CORRECTION MAGNITUDE CALCULATION
CONTROL CONSTANT DEADBAND DATA
OUTPUT
644
MOTOR DRIVER
COMMAND
FEEDBACK

FIG.38

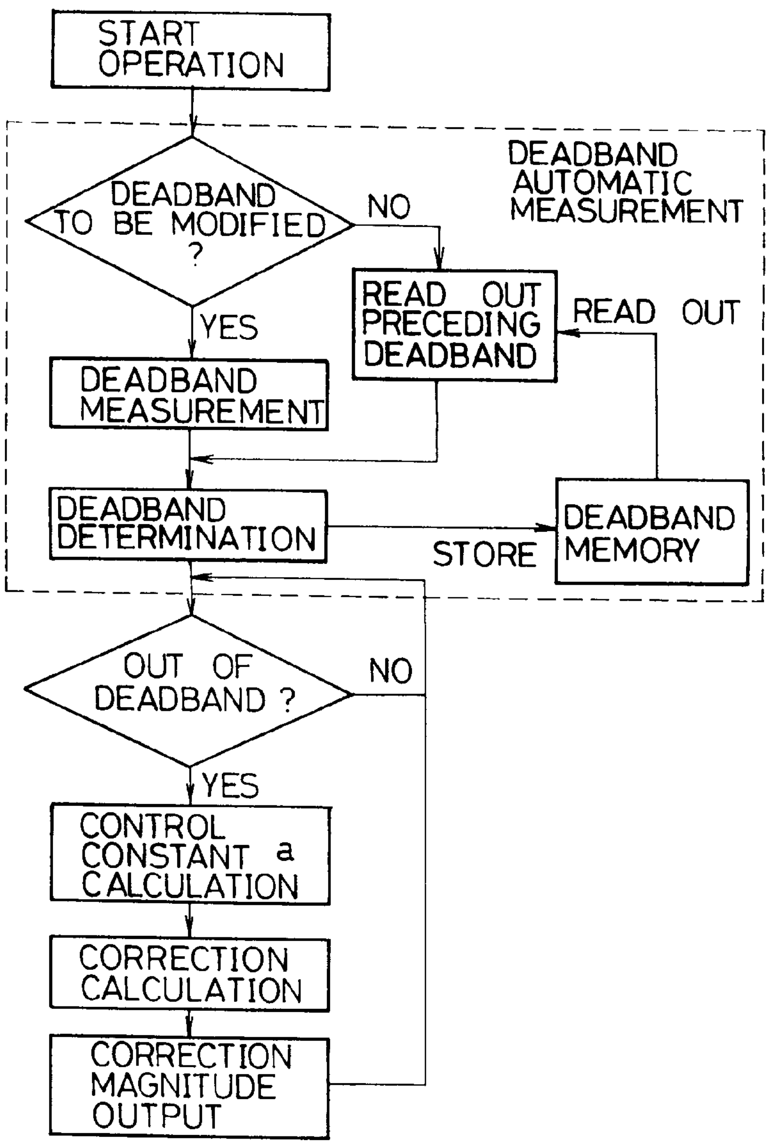

START
OPERATION
DEADBAND
AUTOMATIC
MEASUREMENT
DEADBAND
TO BE MODIFIED
?
NO
YES
READ OUT
PRECEDING
DEADBAND
READ OUT
DEADBAND
MEASUREMENT
DEADBAND
DETERMINATION
STORE
DEADBAND
MEMORY
OUT OF
DEADBAND ?
NO
YES
CONTROL
CONSTANT a
CALCULATION
CORRECTION
CALCULATION
CORRECTION
MAGNITUDE
OUTPUT

FIG.39

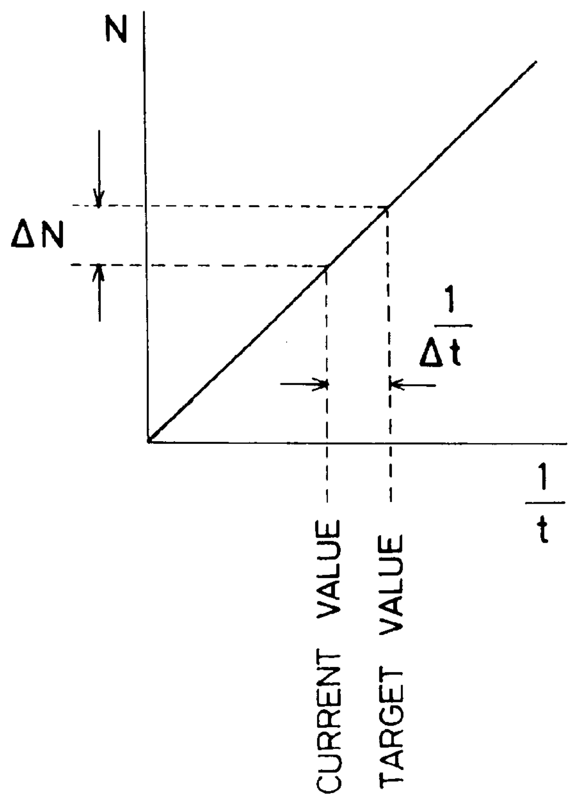


FIG.40A

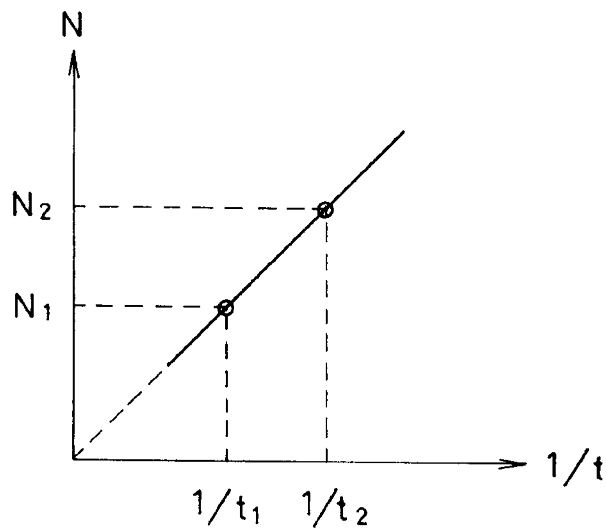


FIG.40B

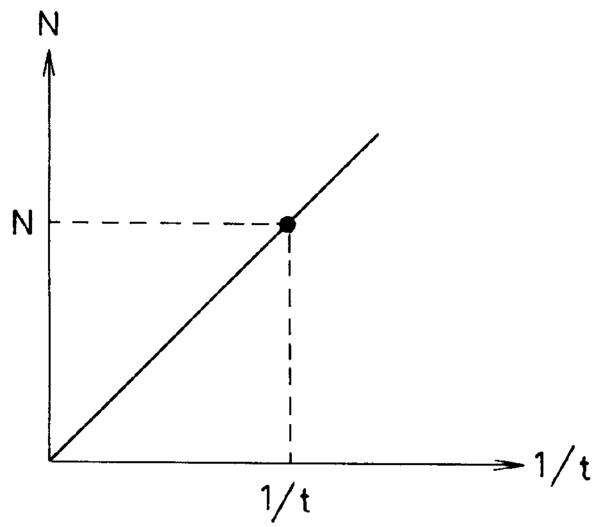


FIG.41A

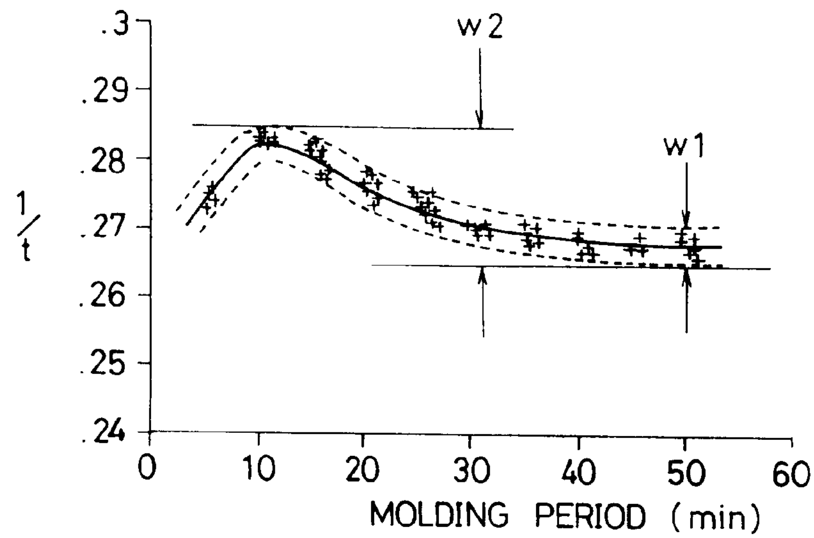


FIG.41B

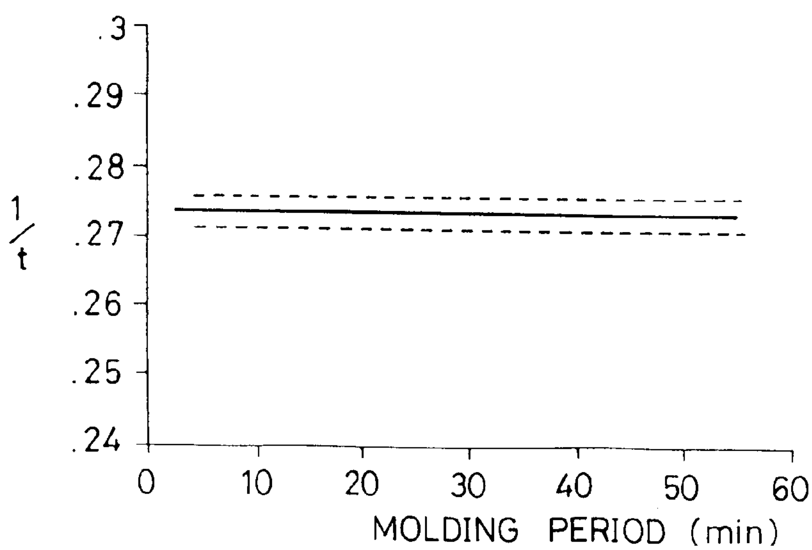


FIG.42A

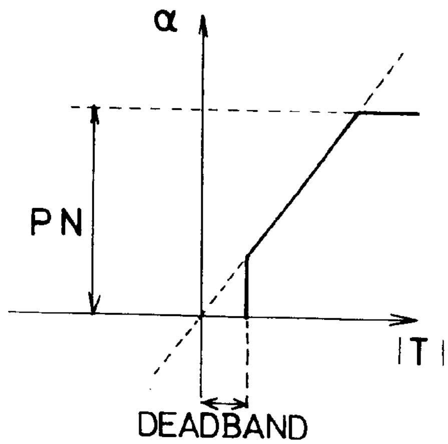


FIG.42B

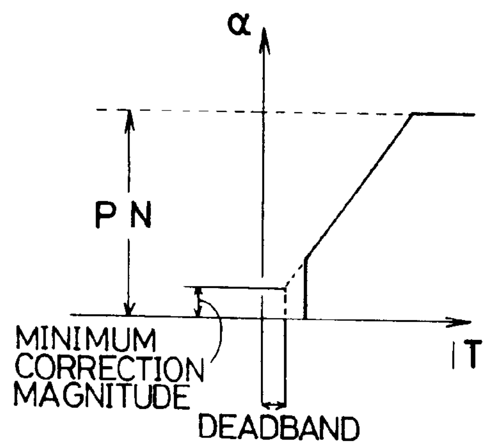


FIG.42C

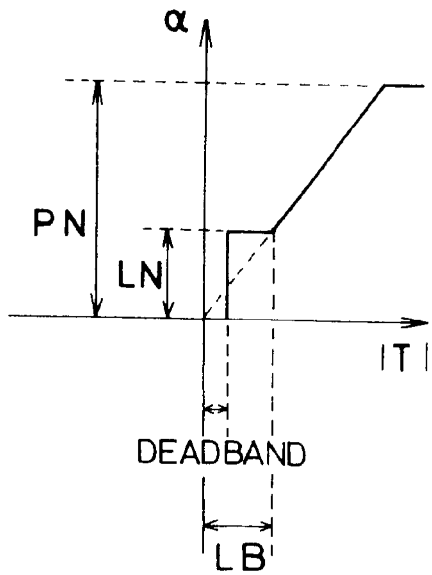


FIG.43

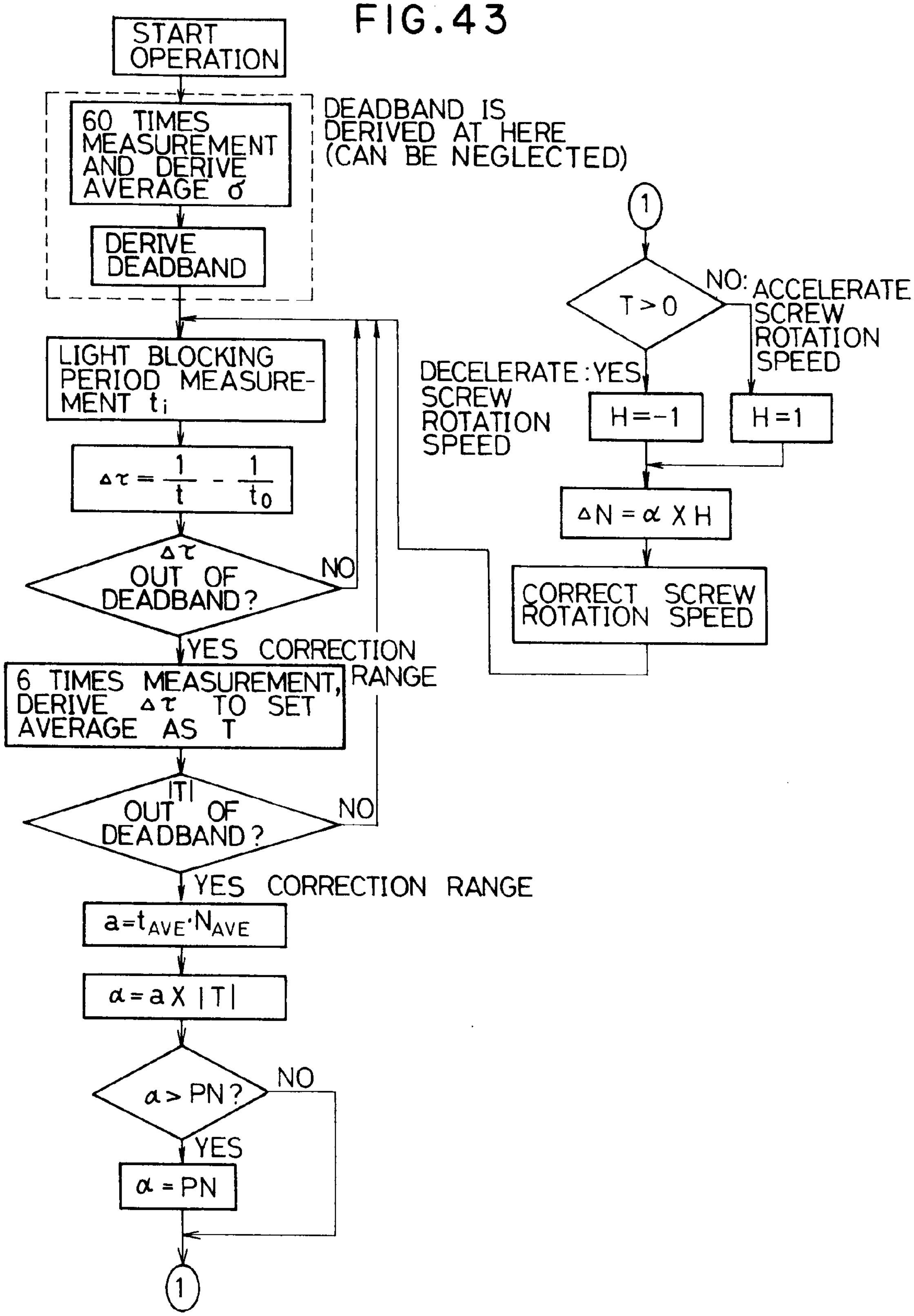

START OPERATION
60 TIMES MEASUREMENT AND DERIVE AVERAGE σ
DERIVE DEADBAND
DEADBAND IS DERIVED AT HERE (CAN BE NEGLECTED)
LIGHT BLOCKING PERIOD MEASUREMENT t_i
$\Delta\tau = \frac{1}{t} - \frac{1}{t_0}$
$\Delta\tau$ OUT OF DEADBAND?
NO
YES CORRECTION RANGE
6 TIMES MEASUREMENT, DERIVE $\Delta\tau$ TO SET AVERAGE AS T
\|T\| OUT OF DEADBAND?
NO
YES CORRECTION RANGE
$a=t_{AVE} \cdot N_{AVE}$
$\alpha = a \times |T|$
$\alpha > PN$?
NO
YES
$\alpha = PN$
1
1
$T > 0$
NO: ACCELERATE SCREW ROTATION SPEED
DECELERATE SCREW ROTATION SPEED: YES
$H = -1$
$H = 1$
$\Delta N = \alpha \times H$
CORRECT SCREW ROTATION SPEED

FIG.44

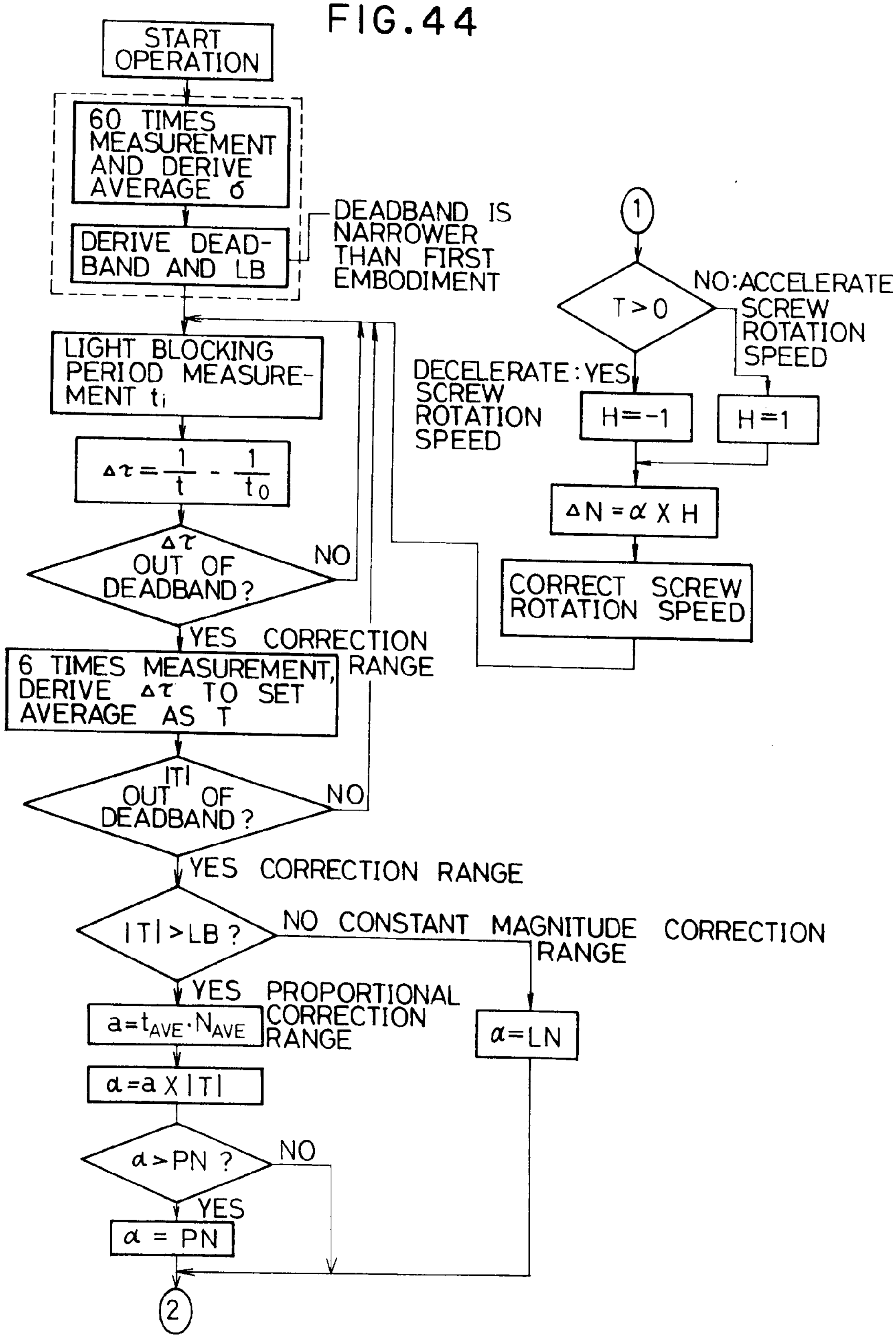

START OPERATION
60 TIMES MEASUREMENT AND DERIVE AVERAGE σ
DERIVE DEAD-BAND AND LB
DEADBAND IS NARROWER THAN FIRST EMBODIMENT
LIGHT BLOCKING PERIOD MEASURE-MENT ti
Δτ = 1/t - 1/t0
Δτ OUT OF DEADBAND ?
NO
YES CORRECTION RANGE
6 TIMES MEASUREMENT, DERIVE Δτ TO SET AVERAGE AS T
|T| OUT OF DEADBAND ?
NO
YES CORRECTION RANGE
|T| > LB ?
NO CONSTANT MAGNITUDE CORRECTION RANGE
YES PROPORTIONAL CORRECTION RANGE
a = tAVE · NAVE
α = LN
α = a X |T|
α > PN ?
NO
YES
α = PN
2
1
T > 0
NO:ACCELERATE SCREW ROTATION SPEED
DECELERATE:YES SCREW ROTATION SPEED
H = -1
H = 1
ΔN = α X H
CORRECT SCREW ROTATION SPEED

FIG.45

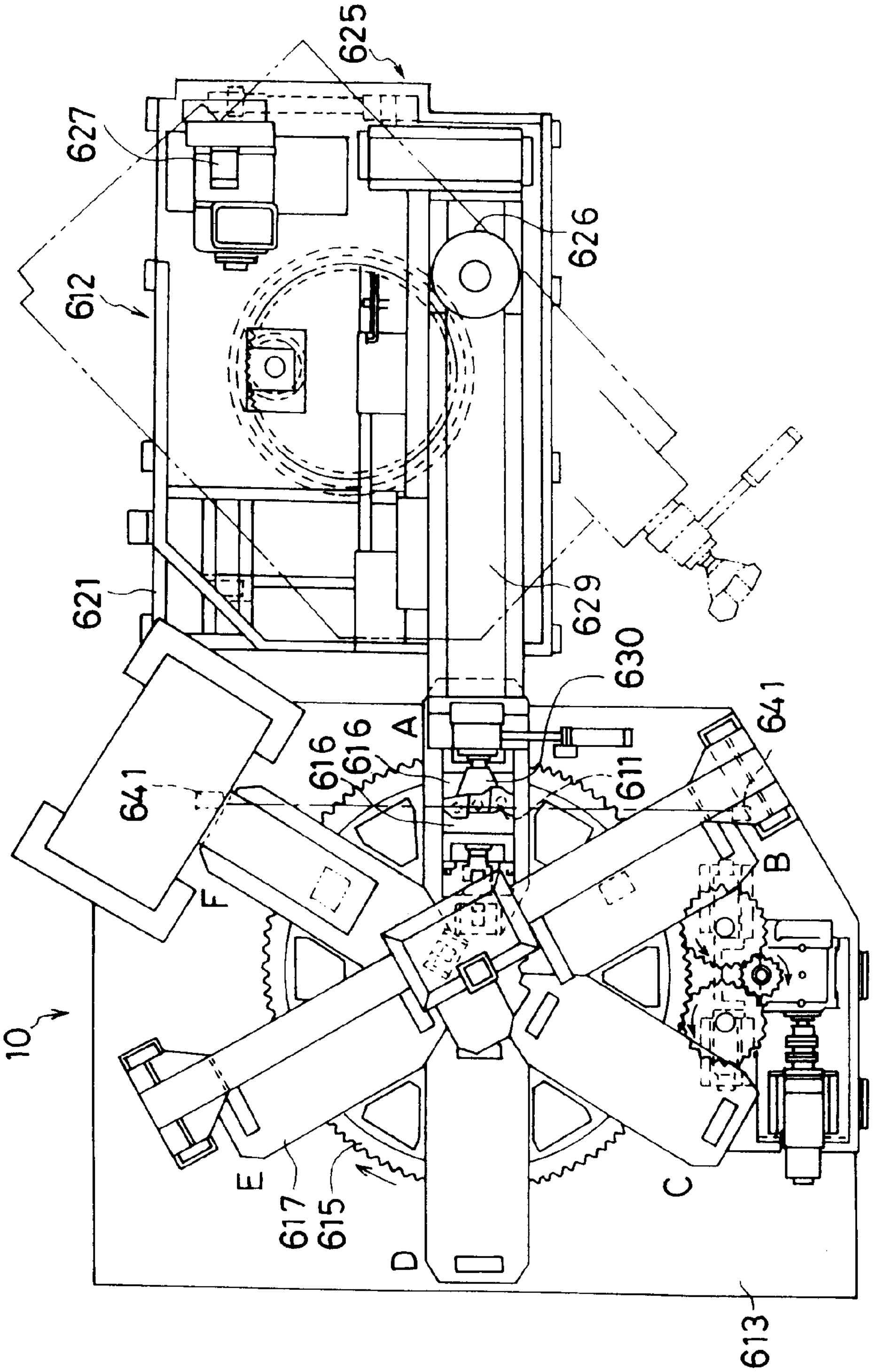
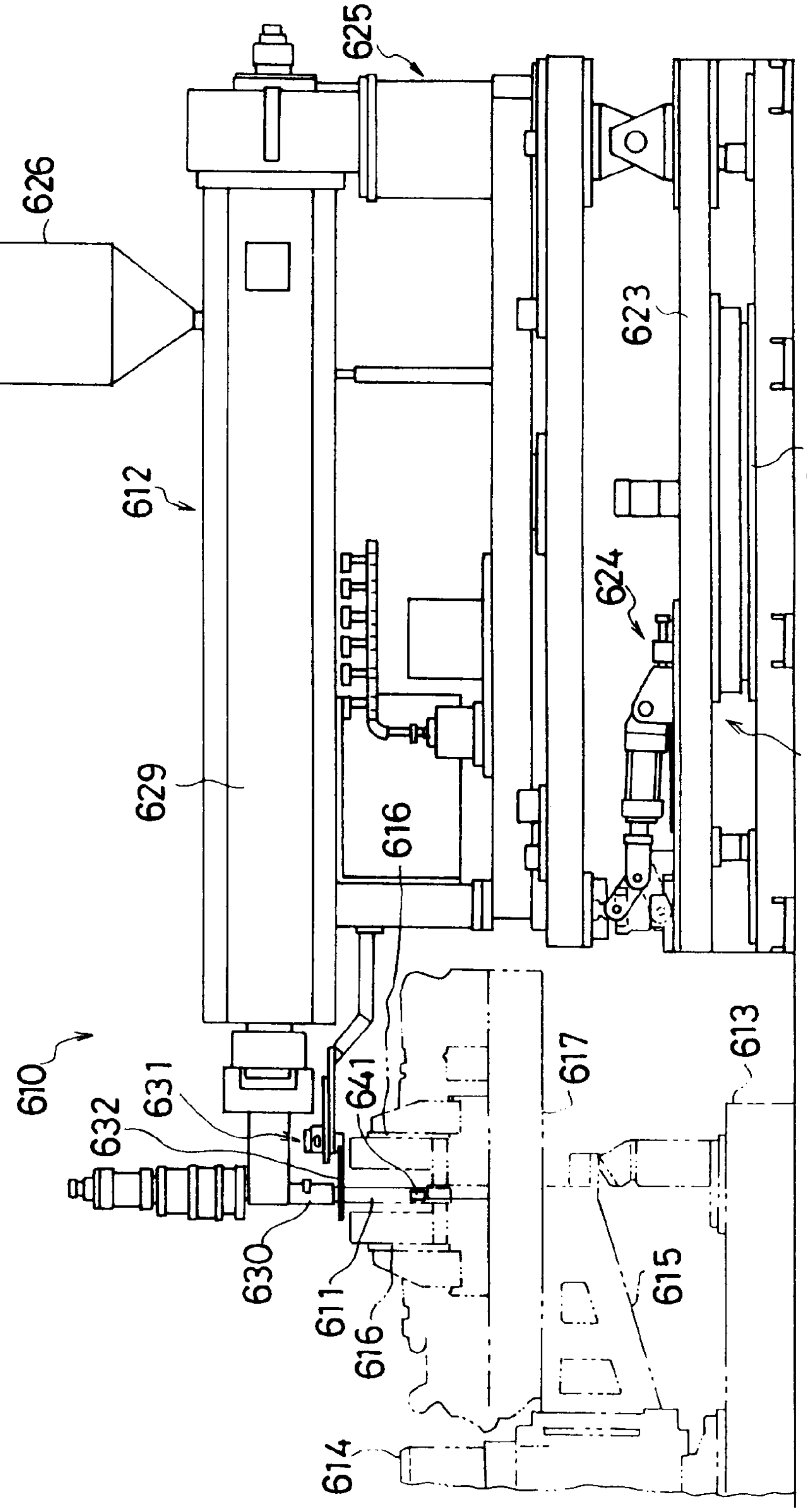

625
627
626
612
621
629
630
A
616
616
641
611
641
B
F
10
E
617
615
C
D
613

FIG.46



610
611
612
613
614
615
616
617
621
622
623
624
625
626
629
630
631
632
641